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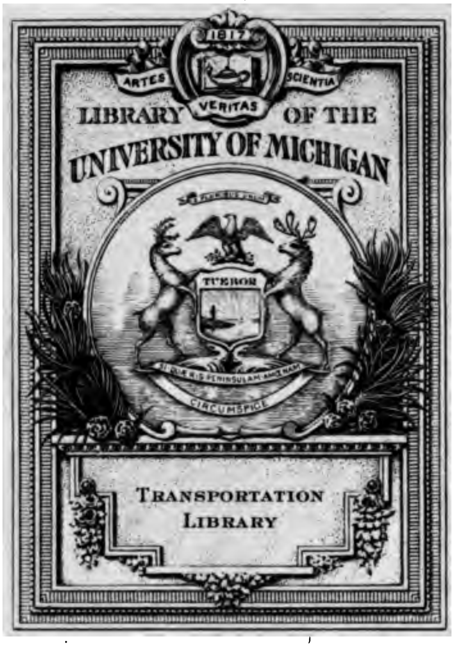
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ON THE CONSTRUCTION

OF

HORSE RAILWAYS FOR BRANCH LINES

AND FOR

STREET TRAFFIC.

BY

CHARLES BURN,
CIVIL ENGINEER.

SECOND EDITION. REVISED AND ENLARGED.

LONDON:
JOHN WEALE, 59, HIGH HOLBORN.
1860.

LONDON:
BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.

Transportation
Library
TF
830
.B96
1860

B9

Grafton
6-21-32
Transport.

PREFACE TO SECOND EDITION.

The rapidity with which the First Edition of this small pamphlet has been sold, demonstrates the growing interest taken by the public in Horse Railways. This has induced the Author to publish a Second Edition, and in doing so, he has taken the opportunity of revising it, and making many additions. It is gratifying to the Author to be able to state, that since the publication of the First Edition six months ago, the first Horse Railway has been opened in England, at Birkenhead.

October, 1860.

ON THE

CONSTRUCTION OF HORSE RAILWAYS FOR BRANCH LINES

AND FOR STREET TRAFFIC.

CHAPTER I.

INTRODUCTION.

Statistics of English and Foreign Railways.—In the report to the Committee of the Privy Council relating to Railways for the year 1857, by Captain Galton of the Board of Trade, the following statistics of English and Foreign Railways will be found.

	Cost per Mile.	Receipts per Mile.	Proportion of Expenditure to Receipts.	Proportion which Receipts, less working Expenses, bear to Capital.
	£	£		
Great Britain .	34,950	2712	47	4·11
France . .	25,668	2706	44	6·58
Germany . .	16,368	2108	53·8	6·43
United States .	8275	1234	54	6·70

This table shows, that although the receipts per mile on English Railways are larger than on all other Railways,—the interest paid upon the total capital is the least.

This apparent anomaly is mainly due to our defective system of Railway Legislation, which has been the cause of great unnecessary cost, and has allowed the construction of competing trunk lines and unprofitable branches.

The proportionate cost of Railways in round numbers, taking the United States as 1, is, Germany 2, France 3, England 4.

This great difference ought not to have existed. The chief material of construction and rolling stock—Iron, is cheaper in England than in other countries, so is also the chief item of working expenses—coal and coke. Labour is dearer in England than in France, Prussia, and most other countries, except America, but experience teaches us that proportionately to the amount of work performed with wages paid—English unskilled labour is but a trifle dearer than in other countries.

Reasons why English Railways have cost more than Foreign lines.—We cannot therefore ascribe the greater cost of English lines to dearness of materials or labour, but we shall find that the chief cause arises from the enormous cost of Land, Law, and Compensation.

The cost of land, law, and compensation on British Railways is from 15 to 20 per cent. on the total cost, whereas on German Railways it is only 7 per cent., equal about to 3¼ per cent. upon the cost of British Railways, or as 6 to 1. This great difference does not arise from the greater value of land in England, which certainly is not more than double that of Germany, but it arises from *our defective system of Railway Legislation.* The cost of obtaining an Act of Parliament, and the enormous law expenses consequent upon opposition from land-owners and rival companies, form a large item in the cost of British Railways from which foreign lines are comparatively free.

There must be something defective in the legislation of a country, in which no undertaking of recognised public utility can be carried out without entailing enormous costs to the promoters for obtaining permission to do so, and without necessitating buying off opponents, or defending its interests against rival companies, or obstinate landowners. If the item of land, law, and compensation had cost in England the same as in Germany—shareholders in English Railways would now be receiving nearly $\frac{3}{4}$ per cent. more interest on their capital.

Other causes of less importance have also tended to swell the cost of English Railways. The works of construction on English lines are on the average heavier and more numerous than on the Continent, and they formerly cost much more than they do now. The English have been the pioneers of Railway construction, and have consequently had to buy their experience—the benefits of this experience have come to us too late, but they have been taken advantage of by other countries.

In addition to the excessive cost of English Railways, another chief cause of the low interest paid to English shareholders is undoubtedly due to the reckless system of constructing opposition Trunk lines, and unprofitable branches.

Other countries have been slow to adopt the Railway system. The English adopted the system immediately its advantages were apparent, but finding the Locomotive Railway answer well in most cases, thought it must be applicable to all. They have consequently rushed headlong into Railway speculation; constructed Locomotive Railways to all towns in the kingdom, and in all directions without any recognised system, and the table at the commencement of this Chapter shows the result.

Advantages that might have accrued from Government control.—In England we are jealous of Government interference in such matters, and perhaps rightly so; still we cannot but think, if Government had laid down the chief lines of Railways and only granted permission to construct those lines, the net revenue from which could be proved from the then existing traffic to return at least 5 per cent. upon the outlay, we should have avoided the waste of capital in constructing useless competing lines and unprofitable branches, and that instead of our Railways now paying an average of 3·75 per cent. interest on the outlay, and 3·06 per cent. on the original capital, they would pay at least 8 per cent.

The low interest paid to original shareholders and the general depreciation of Railway stock in England, has caused such a want of confidence in Railway speculations that the public will not now subscribe to any new Railway undertaking, however advantageous. Few companies think now of advertising for subscribers in the public press, for the obvious reason that it would be useless. The capital is now in most cases raised, by getting the land-owners through whose land the Railway passes, and other interested parties, to subscribe for a third of the capital. The contractor for construction of the works takes another third in payment for work done, and the remaining capital is raised by debentures or preference shares. This system causes the cost of the Railway to be often 50 per cent. more than is necessary, and the original shares are depreciated proportionally in value.

Branch Lines.—Few of the branch lines in England pay remunerative interest upon the capital expended. Branch lines are generally made by the company that constructed the trunk line, or if made by an independent company, are either bought up by the company of the trunk line, or an interest is guaranteed upon their cost of construction ; consequently the greater part of the branch lines in England, instead of proving feeders to the trunk lines and increasing the profits, are suckers and tend to diminish them.

The net receipts of the Lancaster and Carlisle Railway, which at the end of 1857 had not a branch line, paid an interest of 8½ per cent. on the capital. The Newcastle and Carlisle under similar circumstances paid 6 per cent., whereas the Great Western Railway with its numerous branches showed at the end of last year only 3½ per cent. on the total capital, and only 1¼ per cent. on the original capital. The London and North Western having the greatest amount of traffic of any Railway in the world, showed only 4 per cent, on the total, and 3½ on the original capital.

The average cost of branch lines up to 1858 has been £12,700 per mile ; the gross receipts, £600 per mile per annum ; the working expenses, 60 per cent. ; the net receipts, £240 per mile per annum, and the average interest on the capital expended *has not been more than 2 per cent.*

Capital expended on English Lines.—The amount of capital expended on English Railways up to Dec. 31st, 1858, was in round numbers 325 millions. Upon this capital an average dividend of only 3·75 per cent. was paid.

Taking 5 per cent. rate of interest as the marketable value of money in England, when invested in property of fluctuating value or in speculating undertakings, we may consider that all capital laid out upon such undertakings which does not pay 5 per cent. interest, is a loss of capital by so much as the difference the interest represents under 5 per cent.

As the Railways in England pay only 3·75 per cent. interest on 325 millions, it follows that there is a loss of 1¼ per cent. interest on 325 millions, or in round numbers 4 millions per annum, which represents 80 millions of capital.

This is another reason why we think the interference of Government in controlling Railway speculations would have been beneficial, for it would have prevented in a great measure this enormous loss of capital to the country: for although the losses have fallen upon individuals, still, individual losses in the aggregate, whether lost in business or in the construction of Railways, is theoretically, labour and capital lost to the country.

System adopted in France.—In France they have hitherto managed Railway affairs differently. There, the Government will not grant concessions to construct Railways and public works of that description, unless it can be shown by their own engineers, that the net revenue will without doubt return an interest of more than 5 per cent. upon the capital—the principal of political economy being there understood; that capital expended unprofitably is a loss of capital to the country.

The comparative results of the English and French systems on the value of Railway Stock.—One result of the above regulation is, that the value of Railway Stock on the six chief lines in France at this date is

Paris, Lyons, and Mediterranean	175
Paris and Orleans	270
Eastern of France	130
Northern of France	190
Western of France	115
Southern of France	100

an average of 163 per cent.

The gross receipts of the above six lines, 4867 miles long, for the first half of 1859, averaged £2768 per mile per annum. The receipts on nine English Railways, viz., the London and North Western, Midland, Great Western, North Eastern, Lancashire and Yorkshire, Eastern Counties, London and South Western, London, Brighton and South Coast, and North Staffordshire, 4342 miles long, averaged £3055 per mile; but the average value of £100 stock of these lines at that date was only £90.

Another result of this regulation in France is, that numerous large districts in that country are entirely without Railway communication. A glance at the Continental Railway map shows that nearly all the lines at present constructed are trunk lines; that there are no parallel opposition lines, and that few branch lines exist.

The Railway system of France is however not yet completed. Many hundred miles of Railway have still to be constructed. These new lines will be, however, chiefly cross lines, designed with the object of connecting the trunk lines, and giving Railway accommodation to many large and important towns. When these new lines shall have been completed, there will still remain many large and important agricultural and mineral districts, also numerous small towns, quite unprovided with Railway accommodation.

It is not however considered, that the passenger and goods traffic from these districts and small towns, would be sufficient to pay for the construction of expensive Locomotive Railways; nor is it considered, that the high speed of Locomotive Railways is necessary. In order, however, to place these districts upon an equality with the districts intersected by the Locomotive Railways, and to place them in communication with the trunk lines, it is proposed to adopt a system of railroad, which, while it enables passengers and goods to be transported at a greater speed, and with greater economy than by the present system of transport on the common roads, can be constructed at a small cost and will offer a good investment for capital.

Horse Railways in France.—This system is an intermediate system between the Locomotive Railway and the common road; and consists in laying rails along the public roads, and drawing the passengers and goods by means of horses instead of by locomotive engines. An English company has already been formed to carry out about 150 miles of these Horse Railways in the departments of the Pas de Calais and the Puy de Dôme. These Horse Railways are estimated to cost, including horses and rolling stock, about £2750 per mile, and the Government engineers can show that the net revenue will pay an average interest of 15 per cent. upon the capital.

Object of the Pamphlet.—The object of this pamphlet is to advocate the construction of Horse Railways in England and the Colonies, and to show the advantages of this system for the intersection of agricultural and mineral districts; also for branch lines to small towns and large villages, so as to place them in communication with the existing network of Railways.

The advantages of the system for Street Railways, will also be demonstrated, and a description will be given of the various modes of construction that have been adopted, together with improvements that have been introduced by the author and others who have given their attention to this subject.

CHAPTER II.

ADVANTAGES OF ADOPTING THE SYSTEM OF HORSE RAILWAYS IN ENGLAND AND THE COLONIES, FOR THE INTERSECTION OF AGRICULTURAL AND MINERAL DISTRICTS, AND FOR BRANCH LINES.

Railway System in England completed.—In 1857 the number of passengers conveyed per mile upon British Railways was 15,617; in 1858 only 14,944—a decrease of 673, or more than 4 per cent. The interest paid on the total capital was in 1857, 4·11 per cent.; in 1858 only 3·75 per cent.—a falling off of 0·36 per cent. This would tend to show that we have been constructing Railways too rapidly for the requirements. Although 150 Bills for Acts to construct additional Railways, have been presented before the present Parliament, still we think the Locomotive Railway system has been carried out in England to its greatest extent, and that few lines remain to be constructed, which can profitably be worked by locomotive steam-engines. Every large town has now a Railway station, from which a passenger, or ton of goods, can be transported to any part of England, at a speed varying from 25 to 50 miles per hour.

Many Districts and Towns in England unprovided with Railway accommodation.—Although we have constructed all our trunk lines, and many hundred miles of unprofitable branches, there still remain many large districts totally unprovided with Railway accommodation. There are at present many large agricultural districts and numerous small towns and villages in England ten to twenty miles distant from any Railway station. These districts labour under a great disadvantage compared with those adjoining the Railways. A land-owner living 20 miles from a

Railway, must pay at least ten shillings per ton for all goods transported to and from the Railway; consequently he cannot compete advantageously with the other landowners more favourably situated.

Locomotive Railways do not supply accommodation to populous districts.—A Locomotive Railway does not supply the requirements of populous districts.

There are many instances in England of Railways running through populous districts, having stations at every three miles, which still do not afford accommodation to the local traffic. Many turnpike roads communicating with two large towns in the manufacturing districts, have continuous rows of houses on each side, throughout their entire length. Suppose the towns 10 miles distant from each other, with a Railway communication running near and parallel to the road, and having a station half-way between the towns. This would accommodate the inhabitants living near the stations; but many of the inhabitants living along the line of road would have to walk 2½ miles to get to the Railway stations—the average distance being 1¼ mile. Taking the 1¼ mile to be done in 20 minutes —10 minutes upon an average to wait for the train—10 minutes to go by Railway to either terminus, a distance of 5 miles,—the passenger would thus consume 40 minutes upon the journey. If, however, he could be transported from his own door by a vehicle drawn at the rate of 8 miles per hour to the nearest town, 3¾ miles distant, he would only consume 30 minutes, consequently he would save 10 minutes in time and the 1¼ mile walk.

Such is the case with many of the suburban roads in the vicinity of London and other large cities. We may cite as one instance the road from London to Greenwich, with which the Railway may be said to run almost parallel. The Railway accommodates the inhabitants living in the neighbourhood of the termini, but not those living intermediate between them.

Branch Locomotive Lines do not accommodate the intermediate population between the termini.—The line generally chosen for a Railway is a short cut over cultivated fields, through hills and over valleys—avoiding in most cases the old turnpike roads. This is perhaps the most judicious and economical direction to adopt in laying out trunk lines, but it is not so for branch lines, and for the following reasons. The population of all countries live near the established means of communication and along the public roads. The Railway, by avoiding the line of road, consequently avoids the intermediate population, and only accommodates those living near the termini or the intermediate stations.

It appears to be an established principle, and is perhaps almost a necessity with Locomotive Railways, that their halting stations, however small, should have passenger waiting-rooms, goods sheds, sidings, and other accompaniments ; these cost a considerable sum of money, however economically constructed. It appears also to be an established principle that the speed upon a Locomotive Railway, even for a short branch line, whether for the carriage of passengers or goods, must be not less than 25 miles per hour.

To attain this average speed there must not be many halting places. The consequence of this, added to the cost of the station, is, that the least possible number of stations are made, and seldom at distances less than three miles apart, so that the greater portion of the passengers living along the route of the Railway, have to walk or be conveyed at least one mile before they can reach the station. Such is also the case with goods ; they must be transported some considerable distance, and have incurred a considerable cost before they arrive at the Railway station. If, however, the Railway could be laid along the existing public roads, and through the inhabited portion of the country; if also the train could stop anywhere along the route and take up a single passenger—the above disadvantages of the Locomotive Railway would be avoided.

Great Speed not necessary for short Branch Lines.—Great speed is necessary for through routes. The journey from London to Edinburgh should be done in the least possible time consistent with safety. But for short branch lines this great speed is not necessary. A speed of 8 miles per hour for passengers, and 3 miles per hour for goods, is amply sufficient. Assuming the case of a small town situated at the terminus of a branch Railway, 10 miles long, which branch communicates with a chief trunk line—say the line from London to Edinburgh; assume also the station at the junction on the trunk line to be 200 miles distant from London, or 6 hours and 10 minutes journey. Supposing the passenger to travel at the rate of 30 miles per hour on the branch and trunk lines, a distance of 210 miles, he could reach London in 7 hours; supposing he travelled on the branch line at the rate of 8 miles per hour he would reach London in 8 hours.

The same comparison may be made with a ton of goods. We think, therefore, that a gain of one hour for a passenger and three hours for a ton of goods to be conveyed a distance of 210 miles, is not so great an advantage as to warrant any large extra outlay on the cost of the branch line.

By adopting the country roads upon which to lay the rails,—the chief expenses of construction are avoided.—In England we have already excellent turnpike and public roads—constructed with easy inclines, and having all the bridges, culverts, and other works of art ready constructed —the chief population and the chief villages laying along them. These works, constructed by our forefathers at a great expense, are now comparatively useless. The Locomotive Railways have diverted all the through traffic that formerly passed over them, and they are now almost deserted. Our object should be to convert these roads into branch lines, and make them feeders to our trunk Locomotive Railways.

In order to do so, and connect them with our present network of Railways, we have merely to lay rails along the road and connect them with the rails of the trunk line. By using the existing roads, one of the chief items of cost on English Railways—land and compensation, may be reduced one-fourth; we also avoid the expense of cuttings, embankments, tunnels, bridges, viaducts, and other works of art; and consequently, the cost of construction is reduced to laying down the rails and sleepers, and providing the necessary foundation of ballast.

Motive Power for Traction.—The question now arises, What power is most economical and convenient for traction? We cannot use the locomotive steam-engine along the public roads, because the locomotive engine as at present constructed would frighten the horses using the road and impede the existing traffic; we do not require the speed of the locomotive steam-engine, because we have shown that great speed is not necessary; but we can use horses to draw the carriages and trucks, and we shall endeavour to show that this mode of traction is the most economical and convenient, and is amply sufficient for the requirements.

Locomotive Steam Traction Engines.—It may be argued that it would be better to use locomotive steam power to draw the carriages along the public roads, and avoid the expense of laying down rails. Many attempts have been made to run locomotive steam-engines upon the public roads; none have, however, up to the present time proved successful, nor do we know any instance, either in England or abroad, where locomotive steam-engines have been permanently adopted for this object. We will not, however, say that the system of locomotive traction along public roads is impracticable—far from it; there are many circumstances under which it may be used advantageously. Several patents have lately been taken out for traction engines, some of which have answered well; still for a systematic and economical mode of transporting heavy loads, we must *overcome the great loss of power consequent upon overcoming the friction* in travelling over uneven paved or macadamised roads. This can only be effectually done by causing the wheels of the carriages to revolve upon a perfectly even and level surface, and the most practicable method of accomplishing this object is to lay down iron rails. The traction engine will no doubt be found very useful for military purposes, to draw artillery or heavy weights along country roads or over an uneven country, but the circumstances for which they are adapted will generally be exceptional ones, and we are convinced that the traction engine will never come into general use on public roads, nor will it ever supersede horse power.

A Boydell's traction engine of 10 in. cylinder, 20 in. stroke, and 7 ft. driving wheels, with 50 lbs. steam pressure, is stated to be able to draw 50 tons upon a level road at the rate of four miles per hour, but such an engine is working to a disadvantage unless it works up to its full power. In order to carry 50 tons upon a public road, we must, in order not to destroy the road, divide the weight upon a number of bearing points, and we must have at least ten four-wheeled trucks coupled together to carry this load upon a common road. A train of ten trucks can run very easily along a line of rails at a speed of 40 miles an hour, because the rails keep the carriages in one line, and the momentum is consequently directed in one precise direction. But this train could not travel at the rate of even eight miles an hour upon a road without rails, for the reason that the inequalities of the road, and other circumstances acting upon the wheels of each separate carriage, would tend to move each carriage out of the direct line, and perhaps one carriage might have a tendency to move to the right and the succeeding one to the left. This would cause the train, if propelled at that velocity, to take a serpentine course, would cut up the road, and would endanger the ordinary traffic.

Locomotive Steam-Engines on Road Railways.—We believe, however, that under certain circumstances and with a sufficiency of traffic, the transport of goods could be advantageously propelled by locomotive steam power along road Railways. The construction of the engines must be adapted to suit the especial purpose, and the escape of steam must be so managed as not to frighten the horses using the road. The engines, if constructed to travel at a rate not exceeding 10 miles per hour, could be light and powerful. The adoption, however, of locomotive steam power for this object will most probably come, when the advantages of road Railways have been appreciated, and when the traffic upon them has become too great to use horses advantageously.

Horse Power.—As a commencement, and until a perfect Road Locomotive engine is invented, we consider that for public road Railways, to serve the purposes of Branch lines—horse power is the most convenient, will be found to answer all the present requirements, and it will not cause that opposition to the adoption of the system which would most certainly obtain if locomotive steam power were proposed.

By adopting locomotive steam-engines we must use heavier rails, and have a stronger construction of way; we must alter or strengthen many of the existing road bridges, and we must in many cases flatten the present inclines and incur many other expenses. By adopting horse power we avoid most of the above disadvantages.

For drawing loads on smooth rails the horse has an advantage over the locomotive in applying the power. The locomotive must take its purchase from the adhesion of the driving wheels to the rail, and sufficient weight must be placed on the driving wheels to cause that adhesion, otherwise the wheels would revolve on the rail without any progressive motion, and the engine could not move the load, however great its power; so that in this case the advantage gained from the smooth rail by diminishing the friction or resistance to the revolution of the wheels of the load to be moved, becomes a disadvantage to the power employed to move it. The horse takes its purchase from the rough road which is admirably adapted for him as a point of resistance ("point d'appui"), against which he can use his muscles and exert his utmost power.

By using horses, we can more conveniently adapt the *power required to the weight to be moved.* This for economy of transport is an enormous advantage.

Assume the case of an ordinary passenger train upon a branch locomotive line, of 100 passengers, accommodated in one first-class, one second-class, and one third-class carriage. This train will weigh 20 tons.

If we use horse power to draw this train at the rate of 8 miles an hour we should require 5 horses. If the train weighed 40 tons we could add another 5 horses, and if it weighed only 8 tons we should only require 2 horses.

Now, to transport this train of 20 tons on a locomotive line, an ordinary passenger locomotive engine would be used — capable of exerting a useful effect of 200 horses, and drawing 940 tons at the rate of 8 miles per hour.

We cannot economically or practically construct for a small branch line a number of engines varying in power from 5 to 200 horses, but we are compelled to use the same engine for the varying loads. We may lessen its useful effect and cause less consumption of fuel, but we cannot diminish its weight, nor reduce the size of the boiler or machinery, nor diminish its inherent power in proportion to the load required to be moved.

Another great and important disadvantage of the Locomotive railway for light traffic, is the great proportion which the dead weight of the engine and carriages bears to the load required to be moved.

The ordinary passenger Locomotive engine generally used on branch lines weighs with tender 25 tons.

The gross load of the train of 100 passengers will therefore be 45 tons. The passengers with luggage will only weigh upon an average 8 tons, so that 45 tons are obliged to be moved in order to move 8, consequently there are 37 tons dead and useless weight or 4½ times more than the load to be transported.

The locomotive engine is better adapted for high than for slow velocities, for the power required does not increase in the ratio of the square of the velocity.

The useful effect of a Locomotive engine would be greater at a speed of 24 miles, than at a speed of 8 miles per hour, for it can be shown by theory and is borne out by practice that with the same expenditure of power, and with the same engine, double the load can be carried at nearly ⅘ the speed of a single load.

The tractive power of an ordinary passenger engine, with 15 in. cylinders, 20 in. stroke, and 6 feet diameter driving wheel, with an effective steam pressure of 50 lbs. per square inch, would be 3122 lbs. and is capable of moving upon a horizontal plane 312 tons. Its useful effect at the velocity of 24 miles per hour is 200 horse power.

By enlargement of the cylinders, lengthening the stroke, reducing the diameter of the driving wheels and using the same boiler and same pressure of steam, the same engine could equal the force of 200 horses, and move 940 tons at the rate of 8 miles per hour.

Now to transport the train of 100 passengers weighing 45 tons at the rate of 24 miles per hour, only equals 30 horse power, and to move the same load at the rate of 8 miles per hour, only equals 10 horse power—so that by using the above Locomotive engine to transport 100 passengers at the rate of 24 miles per hour we are using an engine of nearly 7 times greater power than is necessary, and to transport the same number of passengers, at the rate of 8 miles per hour, we are using an engine 20 times greater power than is necessary.

We have shown that to convey these 100 passengers, weighing 8 tons, with the above engine, we are obliged to transport a weight of 45 tons, or 5½ tons more than the freight—let us now see the economy of using horse power to convey these 100 passengers along a level Railway at the rate of 8 miles per hour.

A horse can draw at least eight times greater load upon a level Railway than upon an ordinary road, and he can draw 4 tons upon a level Railway at the rate of eight miles per hour. We will suppose the 100 passengers to be conveyed in two omnibuses :

The weight of the 100 passengers .	will be	8	Tons
The weight of the two omnibuses . .	„	4	„
Total		12	„

To draw this load at the rate of 8 miles per hour, we should require three horses; but it will be sufficiently near for our purpose to suppose that we use four horses—two to each omnibus. Taking the weight of the four horses at $\frac{1}{4}$ of a ton each, the total dead weight equals only 5 tons, and the gross weight of the train and horses will be only 13 tons: we consequently save by using horse power instead of Locomotive power 32 tons of useless dead weight; and move 13 tons instead of 45.

The difference in the amount of capital employed on the two systems is also very great. The cost of the materials in the above train, consisting of four horses and two omnibuses, will be about £600. The cost of the Locomotive engine and the three carriages would be about £2600, or $4\frac{1}{3}$ times greater. The cost of tramways laid along the public roads, including rolling stock, will not exceed £2500 per mile. The average cost of branch Locomotive single lines in England, with rolling stock, may be reckoned to cost at the present time about £10,000 per mile, or four times greater.

The total receipts upon branch lines, as stated in page 5, does not average more than £600 per mile, the net receipts £240, and the average interest on the capital 2 per cent. Assuming the working expenses to be the same, and the net receipts at £240 per mile, this will give nearly 10 per cent. interest on the capital required for the Tramway instead of 2 per cent. at present produced by the Railway.

Our object in making the comparison between horse power and Locomotive power, is to show the waste of power and of capital that is expended upon branch Locomotive railways.

The engines and carriages, being specially constructed for great speed, are much stronger and heavier than is required; besides which, with the exception of a few branch lines, the locomotive passenger engines used on the branches are generally of the same description as those used on the trunk lines. Even upon trunk lines the non-paying weight of passenger trains, when full, is for first-class passengers, 700 lbs., and for third-class, 300 lbs.

If the engines and carriages were constructed for a speed of eight miles per hour, and if the power of the engines were adapted to the ordinary weight of passenger trains—using two engines to propel the trains upon extraordinary occasions—the power of the engine and weight of the train might be considerably reduced.

To draw the 100 passengers, weighing eight tons, contained in two carriages, weighing four tons, or a gross weight of 12 tons, upon a railway at the rate of eight miles per hour an engine of 5 horse power, and weighing with tender about eight tons, would be sufficient.

As regards the comparative economy of working the two systems on Road railways—(supposing the Locomotive constructed for slow speeds and for the special purpose)—this will always depend upon the amount of traffic. It is evident however from the preceding comparison, that for light trains of 50 to 100 passengers, such as the ordinary passenger trains on branch lines travelling with a velocity of eight miles per hour—horse power is the most convenient and the most economical.

Horse Railways for the Colonies.—In Great Britain with a population of 230 per square mile, we see that branch railways costing £10,000 per mile, only pay 2 per cent.; it may reasonably be concluded that they will pay less in countries where the population is not so dense.

In our colonies with a scanty population, we are of opinion that a system of horse railways might be most advantageously carried out, and that in most cases they could be constructed, including horses and rolling stock, for £1500 per mile.

In India with a population of 110 per square mile, we are now constructing trunk railways at the low cost of £6000 per mile. These trunk railways will no doubt pay good dividends, for although the population is only half as dense as in England—the cost of construction is small. Up to 1847, 290 miles of railways had been constructed in India at an average cost of £10,300 per mile, and the net receipts showed £420 per mile, equalling 4·09 per cent. interest upon the capital.

We have commenced well in India, and if the system of trunk lines be judiciously carried out, they must prove most remunerative, and will no doubt become valuable property to the shareholders; but a beginning has already been made to construct expensive branch lines. If this policy be continued, the net receipts will diminish far more rapidly than they have done upon English railways.

In India, the annual increase of population is not so great as in England, nor have the great bulk of an Eastern population either the means, the wish, or the need to travel as in England, and therefore we must not look to that rapid development of Railway travelling which in England has been steadily increasing. The object in India for such a density of population should be to construct Locomotive railways for trunk lines of communication, and horse railways for the short branches.

In India and other Eastern countries, business is not generally conducted in such an expeditious manner that it is a matter of vast importance whether a passenger or a ton of goods arrives from a town 12 miles distant in the time of one hour and a half, drawn by horses, or half an hour by a Locomotive engine. It makes a vast difference, however, to the shareholders, for taking the net receipts at £200 per mile, or half the average receipts of 1857 for the trunk lines; this would give an interest of 3·30 per cent. on £6000, the cost of the Locomotive line, and 13·3 per cent. on £1500, the cost of the horse line. If such be the case in India with a population of 107 per square mile, the comparison would be still more advantageous to the horse railway in Ceylon with 64 per square mile, or British America with only 10 per square mile. In fact, for many of the colonies and for opening up new countries, we think it would be always advisable in the first place to construct horse railways and to convert them into Locomotive railways when the increase of revenue warranted the increase of expenditure.

CHAPTER III.

STREET RAILWAYS.

Horse railways for the conveyance of passengers have been carried out to a small extent in England, France, Austria, and other countries. In France is the well known example from Paris to Versailles. The Americans were, however, the first who adopted the system for the conveyance of passengers through the streets of crowded cities. The French give them the credit of the invention by calling horse railways "Chemin de Fer Americain."

Description and Statistics of the Street Railways in the Cities of the United States.—In the United States more than 250 miles of these street railways have been laid down. New York and Brooklyn have 90 miles, Philadelphia 90, and Boston 56 miles of single track. Some of these roads are 5 miles, and others 8 miles long.

In New York they have five roads, and in 1858 they carried upwards of 27,000,000 of passengers, being an increase of 17 per cent. over 1856.

The number of passengers conveyed per mile of double track per annum was last year, 700,000. The gross receipts were £8000 per mile per annum—three times more than the receipts per mile on the Eastern Counties railway; twice as much as on the Great Western; and half as much again as on the London and North Western railway. The working expenses are 60 per cent. of the receipts.

Taking the capital of the various companies as the actual cost of the lines, we find that the cost per mile of single track, including payments for compensation, right of way, buying up opposition omnibus companies, horses, rolling stock, and other expenses, have averaged in New York £22,000 per mile; in Brooklyn £5000 per mile; and in Boston £7000 per mile. It is notorious, however, that the capital of these companies is far greater than is necessary, and that there has been a great waste of capital in jobbery, buying up opposition omnibus companies, and other expenses that might have been avoided. Notwithstanding these drawbacks they pay an interest on the capital from 10 to 12 per cent.

On the 8th Avenue railway in New York, they carry 50 passengers 5 miles in 30 minutes, or at the rate of

10 miles per hour. On the 3rd Avenue railway, which is 6½ miles long, they carry 17,000 passengers daily at a uniform rate of 2½d. each. On the Boston metropolitan railway with a paid-up capital of 430,000 dollars, the gross receipts were for 6 months, from April to October, in 1857, 145,984 dollars; the expenditure 100,844 dollars, the net receipts 46,390 dollars, equalling nearly 11 per cent. on the capital.

Some of the omnibuses carry 100 passengers and travel with two horses at the rate of 5 miles per hour. They are constructed to run in both directions without turning, and a break is attached to them so that they can start and pull up almost instantaneously. At a speed of 8 miles per hour they can be stopped in a distance of 40 feet, and at a less velocity in half the length of the carriage. The omnibuses run on lower wheels than the ordinary omnibuses; the height of the door from the rails seldom being more than 12 inches.

They are constructed roomy inside—having a height of 7 feet, and are fitted up with every regard to the comfort of the passengers, so that ladies and others, who would not ride in the ordinary omnibuses, have no objection to use them.

They are not found to cause any obstruction to the ordinary traffic, and the easy motion causes them to be preferred to the jolting omnibuses; altogether street railways have pleased the public and have been remunerative to the shareholders, and the system is consequently becoming extended every year. The usual charge is 5 cents or 2½d.,—one cent being added for extreme distances or for being transferred from one omnibus to another.

The following is a statement of the cost, earnings, and other statistics concerning the City Railways in New

York, Boston, and Philadelphia, for which information, together with the following extracts, concerning the City Railways of the United States, we are indebted to an excellent pamphlet published by Mr. George Francis Train of Boston, U. S., called "Observations on Street Railways, addressed to the Right Honourable Milner Gibson, M.P."

Statement of the earnings, cost of operating and maintaining the Five City Railroads of New York and Brooklyn, the number of passengers carried by each, the number of accidents ocurring on each, and the dividend paid by each for the fiscal year, ending October 1, 1858.

BROOKLYN CITY RAILROAD.

POPULATION OF CITY—200,000.

Length of City Roads operated—21 miles double track.

	Dols. Cents.
Capital Stock paid in is	1,000,000 :80
Total cost of road, equipment, and its real estate	1,038,839 : 9
Weight of rail per lineal yard, is 64 pounds	
Number of passenger cars for 20 passengers each, is 100.	
Number of passengers carried during the year was 7,705,839.	
Number of miles run during the year was 1,994,186.	
Weight of each passenger car, 4700 pounds.	
Rate of fare for adults 5 cents, for children 3 cents each person.	
Aggregate amount of gross earnings for the year	395,026 : 70
Aggregate amount of operating and maintaining expenses	288,771 : 22
Amount of dividend declared and paid, 8 per cent. on	1,000,000 : 80
Amount carried to surplus fund	18,778 : 85
Total amount of surplus fund to October 1, 1858, including last item	57,125 : 58
Accidents to persons during the year—five.	

SECOND AVENUE RAILROAD IN NEW YORK CITY.

Length of Second Avenue Railroad operated—8 miles single track.

	Dols.	Cents.
Capital Stock paid in 627,000 dols., authorised	800,000	00
Total cost of road, equipment, and its real estate	1,005,403	71
Weight of rail per lineal yard, 72 pounds.		
Number of passenger cars owned by the company, 80.		
Number of passengers carried by them during the year, 4,504,645.		
Speed per hour, including stoppages, average 5 miles.		
Aggregate amount of earnings during the year ending October 1st, 1858	227,457	70
Aggregate amount of operating and maintaining expenses	117,851	96
Amount of dividend declared and paid, 6 per cent. on 627,000	37,620	00
No accident to persons during the entire year.		

THIRD AVENUE RAILROAD IN THE CITY OF NEW YORK.

Length of Third Avenue Railroad operated is 6½ miles double track.

	Dols.	Cents.
Capital Stock all paid in is	1,170,000	00
Total cost of road, equipment, and its real estate	1,378,090	74
Weight of rail per lineal yard, 72 pounds.		
Number of passenger cars owned by the company, 70.		
Number of passengers carried during the year, was 7,945,462.		
Number of miles run by this road during the year was 1,460,000.		
Average weight of each passenger car, 4000 pounds.		
Rates of fare for adults 5 cents. and for children 3 cents. each.		
Average speed per hour, including stoppages, 6 miles.		
Aggregate amount of gross earnings for the year	446,504	13
Aggregate amount of operating expenses	242,811	53
Amount of dividend declared and paid, 8 per cent. on 1,170,000	93,600	00
Payments made for purchases of real estate	77,309	62
Amount added to surplus fund	16,886	93
Total number of accidents during the year was to six persons.		

SIXTH AVENUE RAILROAD IN THE CITY OF NEW YORK.

Length of Sixth Avenue Railroad operated is 4 miles double track.

	Dols. Cents.
Capital Stock paid in is	750,000 : 00
Total cost of road, its equipment and its real estate is	855,957 : 22
Weight of rail per lineal yard is 74 pounds.	
Number of passenger cars in use and owned by the company is 70.	
Number of horses and mules in use, owned by the company is 422	
Speed per mile, including stoppages, 5 miles.	
Number of passengers carried during the year was 5,612,357.	
Number of miles run by this road during the year was 950,572.	
Average weight of each passenger car, 4000 pounds.	
Rates of fare for adults 5 cents, for children 3 cents each.	
Aggregate amount of gross earnings for the year was .	280,617 : 86
Aggregate amount of operating and maintaining expenses was	178,226 : 24
Amount of dividend declared and paid, 10 per cent. .	75,000 : 00
Total funded debt of the company paid off and extinguished	12,844 : 82
Amount contributed for the year to the surplus fund .	14,546 : 80

No accident to persons during the whole year.

EIGHTH AVENUE RAILROAD IN THE CITY OF NEW YORK.

Length of Eighth Avenue Railroad operated is 5 miles double track.

	Dols. Cents.
Capital Stock all paid in is	800,000 : 00
Total cost of road, its equipment, and real estate is .	756,142 : 87
Weight of rail per lineal yard is 72 pounds.	
Number of passenger cars in use, and owned by the company is 61.	
Speed per hour, including stoppages, is 5 miles.	
Number of passengers carried during the year was 6,768,203.	
Number of miles run during the year was 1,028,142.	

Rates of fare for adults 5 cents, for children 3 cents each.

Aggregate amount of gross earnings for the year was .	338,410 : 19
Aggregate amount of operating and maintaining expenses	177,753 : 91
Amount of dividend declared and paid, 12 per cent. on 800,000	96,000 : 00
Amount carried to surplus fund for the year . .	64,656 : 00

Number of accidents to persons during the year, one.

RECAPITULATION.

Number of passengers carried by Brooklyn city roads for 1858			7,705,839
Ditto	ditto	Second Avenue city roads, New York, for 1858	4,504,645
Ditto	ditto	Third Avenue, ditto ditto .	7,945,462
Ditto	ditto	Fourth Avenue, (details omitted) ditto	2,066,000
Ditto	ditto	Sixth Avenue, ditto ditto .	5,612,357
Ditto	ditto	Eighth Avenue ditto ditto . .	6,768,203
Total number of passengers by the five city roads for the year			34,602,506

Total number of accidents on all the city roads for the year, twelve.

DIVIDENDS IN 1858.

Brooklyn City Railroad Company, semi-annually .				8	per cent.
Second Avenue Railroad, in the City of New York				6	,,
Third Avenue	ditto	ditto	ditto	8	,,
Sixth Avenue	ditto	ditto	ditto	10	,,
Eighth Avenue	ditto	ditto	ditto	12	,,

Statement of the City Railroads of Boston and its Suburbs.

UNION RAILWAY COMPANY.

For the year ending November 30, 1850.

	Dols. Cents.
Cost of construction and equipment	476,765 : 00

Total percentage of dividends at the rate of 10.58 per cent. per annum, leaving a surplus of 6178 dollars.

Average number of horses to each car, seven.

Average cost of maintaining each car per day, including wear and tear, feed, salaries, depreciation of property, repairs of road, &c., 10 dols. 50 cents.

Average number of miles run by each car, 12,980 per annum.

Average number of passengers carried by each car, 50,120 per annum.

Average cost of carrying each passenger, $7\frac{5}{8}$ cents.

Average cost of mile run, $20\frac{66}{100}$ cents.

Rate of speed, 8 miles per hour.

The total length of rail on this road is equal to that of a single track in length $9\frac{1}{2}$ miles; the track is paved throughout.

THE METROPOLITAN RAILWAY COMPANY, BOSTON.

For the year ending November, 30, 1858.

	Dols. Cents.
Cost of construction and equipment . . .	444,984 : 41
Total surplus for payment of dividends	66,540 : 77
Dividend of 8 per cent. declared during the year . .	32,152 : 00
Present surplus	34,388 : 77

Average number of horses to each car, twelve.

Gross average cost of maintaining each car per day, including wear and tear, 13 dols. 76 cents.

Average number of miles run in one year by each car, 16,965.

Average number of passengers carried in each car in one year, 102,844.

Average cost of carrying each passenger, $4\frac{7}{8}$ cents.

Average cost of mile run, $29\frac{1}{2}$ cents.

Rate of speed, $5\frac{1}{2}$ miles per hour.

The total length of rail on this road is equal to a single track of 12 miles; it is paved throughout.

MALDEN AND MELROSE RAILROAD, BOSTON.

For eight months, ending November, 1858.

	Dols. Cents.
Cost of construction and equipment	242,548 : 31

Average number of horses to each car, eight.

Average cost of maintaining each car per day, including wear and tear, repairs of road, &c., &c., 8 dols. 23 cents.

Statement of the City Railroads of Philadelphia: Mileage, Equipment, from 1*st January,* 1860.

Corporate Title of Company.	Company Organised.	Road Completed.	Capital. DOLS.	No. of miles of single track.	Cars.	Horses.	Men.
Frankford and Southwark (5th and 6th)	April 23,'56	Jan. 20, '58		$16\frac{1}{4}$	45	275	185
West Philadelphia, (Market Street) .	April 8, '58	June, '58	250000	12	42	204	129
Citizens', (10th and 11th Streets) . .	May 11, '58	July 29, '58	500000	$7\frac{3}{8}$	43	226	117
Fairmount, (Race and Vine Streets) .	April 7, '58	Sept. 8, '58	300000	$5\frac{7}{8}$	26	170	96
Gray's Ferry, (Spruce and Pine Streets) .	May, '58	Sept. '58	500000	$6\frac{7}{8}$	24	121	59
Second and Third Streets . . .	April, '58	October,'58	500000	19	67	410	226
Philadelphia and Darby . . .	August, '58	Dec. 24, '58	200000	8	10	51	20
Girard College . .	May, '58	March, '59	500000	6	18	108	155
Green and Coates Streets . . .	April, '58	May, '59	400000	10	40	290	150
Arch Street . .	April, '58	June 23,'59	200000	7	18	140	108
German Town . . .	Dec. 22, '58	July 19, '59	500000	19	33	250	110
Ridge Avenue and Manayunk . .	March, '59	July 2, '59	250000	$8\frac{1}{4}$	12	95	42
Hestonville and Mantua	May, '59	October,'59	300000	7	15	90	50
North Philadelphia .	May, '59	Novem. '59	75000	$6\frac{1}{2}$	8	56	40
Philadelphia City, (Chesnut and Walnut Streets) . .	May, '59	Novem. '59	750000	4	20	140	80
Richmond and Schuylkill . . .	May, '59	Novem. '59	100000	7	11	50	75
Seventeenth and Nineteenth Streets . .	July, '59	Novem. '52	300000	6	15	90	100
Thirteenth and Fifteenth Streets .	October,'59	Dec. 12, '59	300000	6	20	150	100

The Fifth and Sixth Street Railway went into operation January 20, 1858.—Number of cars run in the city, 32; number of daily trips each, 8; number of miles each car runs daily, 64; number of cars run to Frankford, 8; number of daily trips each, 7; number of miles each car runs daily, 57¾; total trip per day, 312; total miles run per day, 2510; conductor's pay per day, 1 dol. 76 cents; conductor's pay per week (average five days) 8 dols. 80 cents; driver's pay per day, 1 dol. 28 cents; driver's pay per week, 7 dols. 68 cents; number of miles single track, 16¼; number of cars owned, 60; number of horses owned, 279; number of persons under pay, of all grades, 185: number of shares of stock authorised, 10,000.

Tenth and Eleventh went in operation July 29, 1858.—Number of cars run on main line, 28; number of daily trips each, part 7, part 10; number of miles each car runs daily, part 45½; part 65; number of cars running 4 trips, and 26 miles at night, 4; number of cars running on Poplar-street, 1 horse, 3; number of daily trips each, 16; number of miles each car runs daily, 26; total trips per day, 286; total miles run per day, 1794; conductor's pay per day, 2 dols. 40 cents; per week (run 4 or 5 days) 11 dols. 40 cents; driver's pay per day, 1 dol. 50 cents; per week, 9 dols.; number of miles of single track, 7$\frac{3}{10}$; number of cars owned, 44, number of persons under pay, of all grades, 95; weekly amount of wages paid, 949 dols. number of shares, stock issued, 10,000; number of stock holders, 84.

Race and Vine went into operation September 8, 1858.—Number of cars run, 23; number of daily trips each, 10; total trips per day, 230; number of miles each car runs daily, 60; total miles run per day, 1380; conductor's pay, 1 dol. 75 cents per day; per week (run 5 days) 8 dols. 75 cents; driver's pay per day, 1 dol. 25 cents; per week (run 5 days) 7 dols. 50 cents; number of miles, single track, 6; number of cars owned, 36; number of horses owned, 161; number of persons under pay of all grades, 96; number of shares of stock authorised, 10,000.

Second and Third went into operation October 27, 1858.—Number of cars run (Navy Yard line), 35; number of daily trips, 6; number of miles each car runs daily, 66; number of cars run (Richmond and Exchange), 20; number of daily trips each, one-half 7, and one half 10; number of miles each car runs daily, 45½ and 65; total trips per day, 380; total miles run per day, 3,415; conductor's pay per day, 2 dols.; per week, 12 dols.; driver's pay per day, 1 dol. 50 cents; per week, 9 dols.; number of miles of single track, 18; number of cars owned, 69; number of horses owned, 402; number of persons under pay of all grades, 213; weekly amount of wages paid, 1817; number of shares of stock authorised, 10,000.

The following are Extracts from two Reports on Street Railways by Mr. Kneas, and Mr. Easton, Civil Engineers of Philadelphia.

Mr. Easton says—

Popular prejudice is the great enemy with which the advocates of innovation have had to combat, and, strange as it may appear, it is nevertheless practically true, that the more useful the measure advocated, the greater has been the amount of opposition brought to bear against it, even by parties who have subsequently been benefited by the very measures they sought to defeat.

A glance at the early history of turnpike roads will clearly show the difficulties encountered by their projectors; but which, when overcome, became the favoured improvement of the age, and legislative halls sounded with angry debate for their protection, so soon as railroads were proposed, denouncing them as a nuisance, and their corporators as visionary speculators. So it was with the introduction of canals, steamboats, and even gas; the arguments against which, brought forward by the opposition, having in each instance exhibited the grossest ignorance of science, and of the practical effect of the proposed improvements, all of which is applicable at the present day, and has been experienced by those who proposed the introduction of street railways.

The interest which operated against turnpike roads was that of the muleteer; the interest which operated against railroads was that of stage-coach and wagon-proprietors, and in the case of street railways, the opposition is from omnibus companies and antiquated stage communities, whose palpable interest is to defeat a measure, which invades their imagined rights, by the substitution of a means of communication so manifestly useful and necessary, as to completely destroy the system to which they are so faithfully wedded. They use the means employed in their interests to influence, and lead on opposition, until having obtained certain provisoes in the charter for their *especial* benefit, the time has arrived to fraternise with the enemy—when they at once become strong advocates for street railways; and unfortunately, without the influence to quench the flame of prejudice which they have ignited.

* * * * * * *

That increased facilities for commerce and transportation cause greater influx of traffic and travel to the principal streets of large cities, is indisputably recognised, and where the consequent inconvenience of narrow thoroughfares cannot be corrected, it must be modified by economising time and space.

Time is economised by regularity of transit; the cars being quickly stopped by the application of the break, the most refractory horses are immediately arrested: while the whole operation becomes so mechanical, that the horses, when accustomed to the signals of the bell, stop or start without any action on the part of the driver, by which means a time-table can be effectively used, and business men are not subjected to delays incident to the old—and we trust soon to say obsolete—*omnibus system.*

Space is economised, because omnibuses (the most numerous and dangerous portion of the travel), surging from side to side of the streets, are abolished, while the work, heretofore inadequately performed by three of those vehicles, is easily accomplished by one car, in half the time, notwithstanding it is concentrated and confined to one channel.

By the convenience afforded the public by the cars, the side-walks are relieved from pedestrians, and the centre of the street from vehicles; a seat can be taken and vacated without trouble or danger to the occupants of the car, whether invalid or infirm, and the rails present such an even and smooth surface for the wheels of ordinary vehicles, that the drivers avail themselves of their continued use. It is a most difficult matter to dispel from the ignorant or prejudiced mind the idea that the railways will be constantly occupied by continuous trains of cars, which beyond a doubt would block up the street, obstruct the travel, and be a most confirmed nuisance, ruinous to the locality; whereas, in reality, the rails themselves form no obstruction, but rather invite vehicles on the track; the passage of the little car is momentary, as it moves quietly along the street; and the nuisance occasioned by the rattling of omnibuses over the rough stones is abolished, leaving the streets nearly as noiseless as when covered with snow; the advantages of the smooth rail are thus neither few nor unimportant. Any one familiar with the laws of momentum, can readily understand the effect of the constant jar to buildings occasioned by the passage of omnibuses, and particularly in the thronged thoroughfares, where buildings are most elevated.

If, however, the solidity of construction should prevent injurious results, there are many minor disturbances—if not so dangerous, almost as annoying—which cannot be prevented, such as the constant vibration of pier glasses, gas-pipes, &c. (as occasional showers of white flakes, and plaster fragments attest), without enumerating the very serious annoyance to the invalid.

The great reduction of friction on the car, and the smoothness of the rail, obviate all these evil effects by removing the cause.

Here is a picture. A wet day—every corner of the side-walk crowded with impatient pedestrians, each one anxiously peering up or down the street in search of the particular omnibus among the fifteen or twenty approaching, to carry him home, which, with as many more coming in the opposite direction, so effectually choke up the street, that the drays and carts unable to cross at the intersections, render the highway impassable to private vehicles, and are therefore driven to other streets, avoiding danger and delay; the omnibuses crowded to excess, cannot accommodate the vexed crowd on the side-walk, and the sudden halt with imminent risk of collision, with the drivers' "plenty of room, sir," with twenty inside—by no means softens the temper either of those in waiting, or those, who seated—not comfortably—look upon each moment of unnecessary delay as an infringement on their rights.

Here is another—Not an *omnibus* is seen in the whole length of the street—carriages, drays, and carts move with comparative ease, little strips of iron are laid along the street, upon and across which, vehicles pass without inconvenience, and which the drivers (particularly of private carriages), evidently seek; there is no crowd, for the little cars glide along rapidly and frequently, accommodating everybody; at a slight signal the bell rings, the horses stop, the passenger is comfortably seated, no rain drops in from the roof, the conductor is always ready to take the fare when offered, and the echo, "great improvement, this," is constantly repeated.

There is no accident on record, of injury to any passenger of street railways, whilst occupying a seat in the car; some few have happened to boys and incautious persons, from drunkenness, jumping from the cars whilst in motion, &c., but even these are few in comparison with omnibus accidents.

Mr. Kneas says in his Report :—

As to the general usefulness, we can take as a precedent upon which to base an opinion, the great advantage that the present omnibus system, imperfect as it is, affords to all classes of our community. The rapid increase in the number of omnibus lines, each yielding a handsome revenue upon the investment, proves conclusively the large number benefited; and the saving of time to those whose residences are at a distance from the business mart, as well as the benefits accruing to the merchant in rendering his store or counting-house accessible from all sections of the city without fatigue or loss of valuable time, will secure the hearty co-operation to any improvements in the present arrangements that may be suggested.

The advantages of a railroad car over an omnibus, as now used, is self-evident, not only to the passengers, but to those who may reside upon the streets through which the route may be located. The construction of the cars is such as to afford the greatest comfort to passengers, not only in their ingress and egress, but while passing to their destination—the width of the car being equal to the distance from hub to hub of an ordinary coach. The interior proportions will be sufficiently large to avoid many discomforts now so justly complained of.

To the residents upon the route one great advantage will be the relief from the incessant din attendant upon the rapid transit of heavy coaches, so injurious to the invalid, and now urged by many as a serious objection to living upon an omnibus route; their rapidity of motion and security will also be at once appreciated—moving as they can, more rapidly, with less noise, and greater safety than the cumbrous vehicles that now, to accommodate a passenger, or to avoid apparent danger, depend upon the strength of the driver and the willingness of stubborn horses; while with a city passenger *car*, the horses require no lines, further than for guidance around curves, and keeping them within the track; the application of a well-arranged break, alone causing, if necessary, an instantaneous stoppage. They are, therefore, in crowded thorougfares, attended with much less danger than vehicles of ordinary construction and similar motive power.

Their introduction will prevent the streets being, as now, blocked by a double, and frequently a treble row of coaches, creating an intolerable annoyance to the business-man, and will afford to the community greater accommodations in every particular wherein they consider the present system advantageous. * * * *

Again, he says :—

By increasing the gauge to five feet two inches, vehicles travelling upon the track will use both rails without injury to the iron or pavement, and the waggon-edge of the rail will offer no impediment to turning out, should a heavy team be overtaken by a car, and will cause an increased revenue to dray men, carters, &c., by enabling them to haul a larger amount more expeditiously with the same horses.

The mere circumstance of having a railroad track properly constructed upon a street, which to many seems an insuperable objection, is, in my opinion, none whatever, when that track is used solely by horse-power.

One great difficulty regarding its introduction, is to dispel from the minds of those who are most strenuous in their opposition, the idea of an extended train of heavily-laden cars, drawn at a great and unmanageable velocity by steam-power, or where this extreme is not reached, we have the effect of the imperfect track on Third-street to combat; but the roads under consideration are for the use of the same motive-power as the carriages for which is claimed the exclusive right of the highways, and offer less obstruction and danger than an omnibus whose course is erratic, frequently producing a fractured axle or wheel when least expected.

The objection to a single track in the middle of a fifty-feet street, as interfering with the requirements of adjoining tenements is one which will be waived so soon as the experiment is made, for in all cases the carriage-way is twenty-six feet wide, giving a clear space on each side of the rails of ten feet five inches, and of the car in passing—which is but momentary—nine feet six inches, sufficient for all household purposes, and offers no impediment to builders when occupying the street with materials of construction, as it infringes but six inches upon the distance from curb, now allowed them by law.

The further objection that the passage of cars will interfere with the traffic upon the highways is equally untenable, as they will, in fact, be advantageous in keeping the current more perfect; for should a street be occupied to its legal limits with building materials, there is but room for the passage of *two vehicles:* they are therefore confined to specific tracks when there are no rails, then why not allow one stream of carriages to take the rails and follow or precede the car —collisions would be less frequent, and the constant jams caused by three coaches endeavouring to pass through a space sufficiently wide for two only, would be prevented.

The city council of Montreal have also taken some preliminary steps towards the construction of Horse Railways in that city. They have caused inquiries to be made into the working of the system in the large cities of the United States, and have lately published their report, which is most favourable.

The reports of all disinterested parties who have studied the street-railway system in the United States, are unanimously favourable; and the fact of the system becoming so rapidly developed, shows that it is appreciated by the public, and that it answers the purposes of those who risk their capital in carrying it out.

Remarks have been made that, although the system is adapted to the United States, it is not so to England, and that in England it would never answer and would be unpopular.

These remarks are made by those who have an idea that Street Railways would become a monopoly — a monopoly being distasteful to the feelings of the English public. There is, however, no reason why Street Railways should become a monopoly any more than other railways. The company that expends its capital in laying down rails along a street most certainly ought to have some privileges and some rights over its own rails, and its own property, and only those flanged wheeled vehicles that belong to the company, or that pay a royalty to the company, should be allowed to use them.

In the United States they, in many cases, lay down a rail which forms a railway for flanged vehicles, and a tramway for ordinary vehicles,—the form of the rail is shown in Plate 3, fig. 9, and is hereafter described. The ordinary vehicles not having flanged wheels find this tramway a great advantage; and many of the goods waggon proprietors, and those of public vehicles and private carriages, have the gauge of the wheels made to suit the tramway. Did we not know that the contrary was the case, we should imagine that such a system as a combination of a tram and railway and of slow and fast vehicles could not work harmoniously together, but that the velocity of the slowest vehicle must govern the velocity of the whole train we should certainly not imagine that the driver of a brewer's dray or of a loaded goods van would inconvenience himself by moving oft the track to allow an omnibus to pass, unless he were absolutely obliged by law to do so. Such, however, is found in practice to be the case, and no inconvenience results to the railway omnibuses from it; and we must attribute this fact to the moral force which induces the weaker power to succumb to the stronger, although the power of the stronger may not actually be put into effect. We all know that the small pony chaise travelling along the road will make way for the stage-coach—that the small skiff will make way for the man-of-war,—so here the one individual driving the brewer's dray or the goods van gets out of the way of the railway omnibus loaded with 40 or 50 passengers.

Few men will be found to have the courage to put 40 or 50 passengers to inconvenience by impeding their journey and wilfully interrupting their progress. Should at the commencement of the street-railway system in England, many cases occur of the railway omnibuses being wilfully impeded by interested parties—this will soon right itself. One or two examples will occur of the 50 passengers in the omnibus forcibly removing the obstruction,—the public will be in favour of the system, and will uphold the rights of the many against the few and all opposition will very soon cease. Many difficulties which present themselves and which appear insuperable in theory, are often imaginary and vanish in practice, and this question of the right of way for street-railway omnibuses is one of them.

Should, out of deference to this feeling of creating a monopoly, there be any unwillingness on the part of Municipal authorities or the Commissioners of Roads to give Horse Railway Companies any right of way, the difficulty can be overcome by adopting several ingenious contrivances for a movable or shifting flange to the wheels, hereafter more particularly described in page 60, under the heading "Rolling Stock." These contrivances, to enable omnibuses to run off the track, will be found of great advantage, and afford many facilities for the working of the street-railway system ; but we consider that except in localities where absolutely necessary, the street-railway omnibuses should never move off the track or get out of the way of other vehicles. If they once give way, they will always be compelled to do so, and this will in a great measure destroy the advantages to be gained by adopting the street-railway system ; but where it is known that omnibuses cannot get off the track, drivers of other vehicles will naturally and instinctively get out of their way. We are convinced that the English public will soon become accustomed to the Street Railway as they have done in the United States, and will soon appreciate the increased comfort, convenience and speed.

Independently of the benefits arising from the adoption of Street Railways to the general public, and to the companies who construct them, the system is good as a matter of policy, and ought to be encouraged by the municipalities of all large populous cities. The Street Railway, with its large and commodious omnibuses, concentrates the traffic into a small space and prevents that overcrowding the streets, which in London is becoming an evil almost insupportable. The omnibuses being large, commodious, and well ventilated, and travelling at a speed of 5 to 8 miles per hour, with an easy motion, are found in New York to be used by a class of people who would otherwise avoid the ordinary ill-ventilated, over-crowded, jolting omnibuses, and who would in this country use cabs. A file of cabs to contain 100 passengers would be a quarter of a mile long, whereas, if contained in large omnibuses, containing 50 passengers each, would be about 50 feet, and would not take up more than one-twentieth of the space. Lessening the traffic lessens the wear and tear of the roads. Added to this, the company constructing the railway would keep their own road in repair, which would be on an average one-fourth of the entire width of the street, and would also have to pay for a right of way, so that the company would become in several ways a source of profit to the municipality.

We are convinced that the system of Street Railways might be carried out with great advantage in many of the large towns in England, and would prove most remunerative speculations.

In London they could not perhaps be carried out to the same extent as in New York, Philadelphia, and other cities in the United States, for the streets in those cities are broad and straight and well adapted for the system, whereas, the streets of London are mostly narrow and crooked; but still there are many lines of streets in London where tramways could be laid down most advantageously. The line from Farringdon Street, along Holborn and Oxford Street to the Edgeware Road, is one of many which is well adapted for a tramway. The passenger traffic is enormous, and the speculation would no doubt pay well, provided the company obtaining permission to do so, was not saddled with exorbitant charges for right of way and compensation.

Mr. Thomas Wright, C.E., endeavoured ten years ago to form a company to construct Street Railways in London, but the advantages of the system were not then sufficiently well known by the English public.

A proposition was also made, three years ago, by a company to construct Street Railways in London, but the project did not receive the approval of Lord Llanover, who was Chief Commissioner of Works at that time, and was consequently abandoned.

Any proposition to construct Street Railways in the heart of London will no doubt meet with great opposition.

There are, however, numerous other fields of operation for applying the system without constructing them in the heart of London, and which would be better adapted for the first experiment.

They would be admirably adapted for the suburban lines of communication—such as from London to Greenwich—Camberwell, Clapham, Peckham, Hammersmith, Richmond, Notting Hill, Hampstead, Hackney, Stratford, Kingsland, &c. &c.

There is also a large field for trying the system in the large cities of the United Kingdom, such as Dublin, Manchester, Liverpool, Glasgow, &c. We believe that when once a commencement is made to construct Street Railways in England they will prove so remunerative to the shareholders, and so favourably regarded by the public, that they will be generally adopted, and we think the time is not far distant when such will take place.

Public attention in England becoming directed to the advantages of the system.—Public attention in England has lately become directed to the advantages of the horse-railway system. Many articles have been devoted lately by the "Engineer," "Builder," and other engineering journals to a consideration of the subject. "The Times," "Daily Telegraph," "City Press," and other daily journals, have also advocated the system.

An excellent pamphlet on the subject was written in 1857 by Mr. Edmund Sharpe of Lancaster, published by Simpkin & Marshall of Paternoster Row, and entitled "A Letter on Branch Railways, addressed to Lord Stanley of Alderley, President of the Board of Trade." This small pamphlet is well worth perusal, and contains many good and practicable suggestions, and much valuable information. Mr. W. B. Adams has been for some years the strenuous advocate of the system, and has written many able articles in support of it, in "The Westminster Review," "Journal of Arts," and other periodicals. The pamphlet describing the progress of the street-railway idea in England, that has been lately published by Mr. Train, and from which we have extracted the valuable statistics of the Street Railways in the United States, has done much to awaken the English public to the advantages of the system.

A Bill was introduced during the present session of Parliament by the late Sir Robert Ferguson, entitled "A Bill for facilitating internal communication in Ireland by means of Tramroads," the object of the Bill as stated in the preamble being, to give "Power to persons desirous to promote the construction of Iron Roads or Tramways in Ireland, to make use for that purpose, under proper control, of Public Roads, Post Roads, and Common Highways, where the same can be done without interfering with public interest, and to purchase and hold such lands as shall be found useful and necessary for the completion of such undertakings, and to use such Tramways for the conveyance of Passengers, Produce, Minerals, Merchandise and other goods, in carriages, waggons, or trunks drawn by horses." A similar Bill has been introduced for Scotland.

In France, as already stated, it is intended to carry out the system to a great extent in the agricultural and mineral districts for the conveyance of passengers and goods. An English Company has already been formed with the object of carrying out about 150 miles of these lines, and a concession for one line has, we believe, been already granted to this company. The company has also the object of carrying out Horse Railways in England—we think, however, it will be necessary to obtain a general act for England, on the same principle as the act for Scotland, before any company will be able to carry out works in England on a large scale.

As the advantages of Horse Railways have been long since appreciated in the United States, where they have been carried out with most beneficial results, and as the advantages of the system are now admitted by France—in which country they are also about to be extensively carried out—we trust that the example set us by the United States and France will be followed in England, and that we shall soon see their general adoption in this country.

Unfortunately one of their chief advantages—economy in cost—becomes a disadvantage to an important and influential class of persons who promote such undertakings. It will also be some time we think before a Horse Railway Company can obtain the status of a Locomotive Railway Company, or the same wish on the part of influential people to become directors. The object however is the same, viz., the conveyance of passengers and goods with a view to profit. The difference is alone in the motive power employed. The Great Western Railway, with its splendid bridges, viaducts, and other works of art, and its magnificent terminus at Paddington is grand and imposing to contemplate, as a triumph of what skill, enterprise and capital can accomplish, and we ought to be proud of it, but unfortunately for the original shareholders "it does not pay." The shares stand now at 70, or 30 per cent. discount, showing that one-third of the capital has been spent unprofitably, and therefore never ought to have been expended at all.

The simple Branch Horse Railway will never be imposing to look at, but if it should pay 10 per cent., and its shares stand at 200 instead of 70, it would very soon command as much public interest as the more magnificent trunk lines.*

CHAPTER IV.

CONSTRUCTION AND COST.

The system of Horse Railways advocated in this pamphlet being to lay the rails along the existing public streets and roads, the works of construction are so trifling that little remains to be described except the construction of the "Way," comprised under Rails, Sleepers, and Ballast.

In the case of branch lines where it may be necessary from certain local difficulties to divert the line of tramway from the road, the construction of the cuttings, embankments, bridges, and other works of art will be nearly the same as for ordinary Locomotive railways. There are, however, certain points in the construction of the "Way," which materially affect the entire system and which it will be necessary to notice. One of the most important is the width of gauge.

Gauge.—To determine this question, with respect to branch lines, we must first consider whether it would be judicious that the rails of the branch horse lines should join on to the rails of the trunk Locomotive line, so that the rolling stock of one could be used on both. Mr. Sharpe in his pamphlet, to which we have already alluded, argues with much force and with good reasons, that it would not be judicious, and is not necessary,—and even if the branch lines were so constructed as to admit of the trucks of the main line passing over it, it is on all accounts desirable that they should not do so. We fully concur in his opinions, and cannot do better than quote the entire chapter he has devoted to this question. He says :—

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* Since the publication of the first edition of this Pamphlet, much progress has been made in developing the system in England and abroad. A Street Railway has been laid down at Birkenhead, and was opened on the 30th of August last with much *éclat*. For the honour of having the first Street Railway in England, Birkenhead is indebted to Mr. Train, through whose energy and perseverance it was carried out. It has now been in operation for more than a month, and has fully answered all the expectations of the inhabitants, as well as of those who laid it down. The example of Birkenhead will soon be followed by Liverpool, Manchester, Birmingham, Glasgow, and London,—in fact, arrangements are at present in negotiation for carrying them out. The author is also about to construct many miles of Horse Railways in England, France, and other countries.

"It is needless to inquire into the circumstances that fixed the gauge of the Manchester and Liverpool Railway at the remarkable measure of feet inches and fraction of an inch, which is neither the multiple nor the aliquot part of any known dimension. It is sufficient for the unlearned in such matters to know that the adoption of 4 feet 8½ inches as the width between the rails of that railway, necessarily repeated in the branches and extensions of that undertaking, and subsequently adopted by the legislature, as the gauge on which the whole of the extensive system, of which that railway, in its enlarged dimensions, may be said to be the centre, was the result of accident and not of design. To speculate, at the present day, however, on the superior practical advantages of any other gauge as applicable to this system, were equally idle ; it is self-evident that all *continuous* extensions of this system, for the carriage of *through* traffic, must be designed on the model of the original ; and we have reason to be thankful for that act of the legislature, which defined and limited all departures from this standard measure in the main lines of the kingdom.

"This remark, however, does not apply to such lateral and limited extensions of the railway system as those at present under discussion. The main lines of the kingdom are all constructed, the branches—the feeders of the parent system—principally remain to be added. An exception must be made in favour of these smaller undertakings, or railway extension is at an end. To refuse to the remoter districts and out-lying towns the minor facilities within their reach, which will sufficiently serve their purpose, is to prohibit to them the advantages, which the legislature has accorded on a larger scale to their wealthier and more prosperous neighbours. To continue to do so were equally impolitic and unjust to existing Railway Companies as to the interests in question. The railway system, as it stands at present, is limited, exceptional, incomplete. The trunk of the tree is fully developed, but the boughs are wanting: the back-bone is there, but the ribs remain to be added before the skeleton can be said to be complete: the larger arteries exist, but it is by the smaller blood-vessels that fresh vigour and healthy action is to be infused into the whole system. No such system can, in other words, be said to be complete, which does not possess its minor channels of communication, its tributaries and feeders, diverging from the main channel on each side, spreading and ramifying in every direction; drawing produce and carrying traffic into and out of every town, village, hamlet, and homestead within its reach. This is what the railway system must become, or it will fall short of its mission. This is, however, what it will never become until these tributary lines are permitted to bear, in the size and extent of their works, the same relation to the principal lines, that, in other similar systems, the branches bear to the main trunk.

"The first privilege, then, to be accorded to the promoters of these secondary railways is, that they shall be at liberty, in the construction of their lines, to adopt a gauge other than that of the main lines. This is not a matter of slight moment: the question involved is not that of the purchase of a few yards of land, more or less; every item of cost is affected by the increase of the width of the railway. The weight of the rail, the strength of the sleeper, the depth of the ballast, the breadth and contents of the cuttings and embankments, the width and strength of the bridges and culverts, and, lastly, the size and weight of the rolling stock, are all increased by every inch that is added to the width of the permanent way, and are, in like manner, diminished by its reduction. The narrow mineral railways of 2-foot gauge and upwards, existing in different parts of the kingdom, and costing from £800 to £1200 per mile, illustrate the extent to which this reduction, dependent principally upon width of gauge, may be carried.

"It is not absolutely necessary that these secondary railways should all be of one gauge, but for the sake of uniformity, and consequent economy in the construction of the rolling stock, and other necessary appliances, it is, on the whole, desirable that they should be so. The gauge, then, should be such as, without increasing too greatly the cost of construction, will admit of the use of Locomotive engines and passenger carriages of sufficient breadth. Three feet would appear to be a width, which, intermediate as it is, between that of the mineral tramway of 2 feet and that of the ordinary first-class railway of 4 feet 8½ inches, would meet both these requirements, and be in other respects a suitable one for the purpose; and it is upon consideration, and not without a certain practical experience in the matter, that I venture to recommend this gauge as the one to be adopted for the whole of these secondary railways.

"To the adoption of any gauge, other than that of 4 feet 8½ inches, an objection is likely to be urged, which it may be well here to notice and meet. It may be said, that the cost of unloading and reloading the goods from the smaller wagon into the larger one, at the point of junction with the main line, is an additional tax upon the secondary railway, which, were the gauge of both lines the same, it would not have to bear. This objection is valid in regard to goods only, to a certain extent; in regard to passengers it is certain, that, in either case, they would have to change carriages at the point of junction, this being the universal practice, on all branch lines of ordinary gauge, at the present time. In respect to goods it would be valid only where the cost of thus transferring the traffic counterbalanced the interest on the saving realised in the construction of a cheaper line. Now the cost of transferring coals and lime from a railway truck into carts at the different stations is rendered, by an arrangement that must be familiar to all, absolutely trifling; and there is no reason why the same arrangement should not be adopted for the wagons of a tramway for all similar materials. Blocks of stone or marble, flags, timber, sacks of grain, packed goods, and bales of all kinds are transferred by a crane with the greatest ease. There would still remain a portion of the traffic that could only be moved by manual labour; but an average charge of threepence per ton for all descriptions of goods would amply cover the amount of this tax. This objection can, therefore, at best, only apply to branch lines not exceeding 3 or 4 miles in length, if any such, to supply a district so entirely within what may be called the marginal limits, or reasonable reach of the main line itself, be at any time required. But, beside the sufficient answer here given, there is another of a much more fatal and insuperable nature. Even if the branch line were so constructed as to admit of the trucks of the main line passing over it, it is on all accounts undesirable that they should do so; or rather, that the smaller company should be thus dependent, for the accommodation of its traffic, on the larger one. The complications that daily arise on the main lines, sufficiently prove the inexpediency of this arrangement. Few of the larger companies have wagon stock sufficient for their own purposes; and when the pressure arising from this deficiency begins to arise, it is the traffic of the branch which is the first to feel it. Neither, on the other hand, is it desirable that the wagons of the branch should be sent on the main line. The moderate stock that would be sufficient to work the traffic on a 10 or 15 mile Railway from end to end, would be totally insufficient to send that traffic to a distance. When a truck shall once have left the line, the time of its return would be a matter of most uncertain calculation; and to burthen the branch with the large amount of expensive stock, that would in this case become necessary, would be to defeat the object proposed to be accomplished. Lastly, the handling of the light stock of a 3-foot railway at each terminus would be easy and inexpensive; the strength of a man is equal to the moving of a 3-ton truck; horse-power is requisite to shunt one of 6 or 8 tons. These considerations appear to offer an unanswerable reply to the natural objection founded on the break of gauge; the interests of the branch would, in fact, demand that the break should occur, *whether the gauge were the same or not.*"

It is necessary to state that Mr. Sharpe advocates two classes of tramways, one for Locomotives, and the other for horses; and that he does not propose to lay the rails along the existing public roads. If the rails were laid along the existing public roads, as we advocate, the diminution of gauge from 4 feet 8½ inches to 3 feet, would very slightly diminish the cost of construction, but it would effect a great diminution in the cost of the rolling stock.

This is an important advantage, and added to the other reasons which Mr. Sharp gives, convinces us that a diminution of gauge would be desirable. We think, however, that 3 feet is too narrow, especially if the line be intended for passenger traffic. An omnibus to hold two rows of passengers sitting sideways to the direction of the line and opposite each other, ought not to have a less width inside than 5 feet. This difficulty might be overcome even with a 3 feet gauge; still for many reasons we think a wider gauge would be desirable—say 3 feet 6 inches.

There is, however, another point connected with the width of gauge, and a most important one, which we must consider if we use horses as the motive power. It is necessary that the tread or path of the horse should be on the paving or road and not on the rail. If we use two horses abreast, the tread of the two should be either outside or inside the rails. The width of roadway taken up by two horses abreast is 4 feet. The distance between the rails on the Paris and Versailles tramway is 4 feet 8 inches; so that the path of the two horses is just inside the rails. If we adopt a gauge of 3 feet, the tread of the two horses will fall just upon the middle of the rail, nor should we get rid of the difficulty if we adopted a gauge of 3 feet 6 inches or 4 feet; consequently if we diminish the gauge, we must use the horses in single file, or use three abreast. For street railways we cannot conveniently yoke two or more horses in single file, but if more than one horse be used, they must be yoked abreast; also for street railways we should for many reasons adapt the gauge to the gauge of the ordinary omnibuses and other vehicles. The gauge of the Paris and Versailles tramroad is 4 feet 10¼ inches; that of the street railways in the United States is the same as the Locomotive railways, 4 feet 8½ inches. The average gauge of ordinary carts and carriages in England is 5 feet; of the new London omnibuses 5 feet 6 inches.

We think for many reasons it would be desirable to have the gauge of street railways, the same as for locomotive railways, especially in London, as we deem it not impracticable that goods from one railway terminus could be transported on the railway trucks during the night through the streets of the city to another railway terminus, and by that means free the streets in a great measure during the day from the cumbersome and unsightly goods vans. Taking all points into consideration, the gauge which we should recommend for horse railways in country roads is 3 feet 6 inches, and for street railways 4 feet 8½ inches.

Curves.—The omnibuses upon the street railways in New York, having wheels at distances of 6 feet between centre and centre, can turn readily in curves of 60 feet radius; with the wheels nearer together they can turn safely in a curve of 40 feet radius. For ordinary constructed carriages with the wheels not less than 5 feet apart from centre to centre, and a gauge not less than 4 feet 8 inches, the minimum curve should not be less than 50 feet radius, and with 3 feet 6 inches gauge, 30 feet radius. In Boston and Philadelphia, the sharpest curves are 1 in 33.

Gradients.—The tractive force required to move an omnibus, containing 50 passengers with luggage, and weighing 6 tons, would be on a level only 60 lbs. Up an incline of 1 in 100, it would take three times the power; up 1 in 50, five times the power; and 1 in 25, ten times the power; it is therefore a matter of great importance that steep inclines should be avoided. Another and most important point must also be taken into consideration, in laying out horse railways, viz. *that the advantage of the* *rail over the road is much diminished when the load has to be pulled up steep inclines.* The advantage of the rail over the road is on a level, under ordinary circumstances as 8 to 1, but up an incline of 1 in 100, it is reduced to 3 to 1, and up an incline of 1 in 25 it is reduced to $1\frac{3}{4}$ to 1. This apparent anomaly is due to the greater proportion which the friction bears to the gravity of the load in ascending inclines upon common roads.

Assuming the load to be 1 ton or 2240 lbs. the resistance to be overcome to draw this load on level rails is 10 lbs. Up an incline of 1 in 100, we must add the resistance of the gravity of the load due to the rate of inclination, or 22lbs.; therefore the total resistance is 32 lbs. —requiring 3 times the power. Up an incline of 1 in 25; we must add for gravity 90 lbs., therefore the total resistance is 100 lbs.—requiring ten times the power.

The resistance to be overcome to draw a ton on a level road is on an average 80 lbs. Up an incline of 1 in 100, we must add for gravity 22 lbs., total 102 lbs.—requiring $1\frac{1}{4}$ times the power. Up an incline of 1 in 25, we must add for gravity 90 lbs., therefore the total resistance is 170 lbs. —requiring only twice the power; so that the comparative resistance of the rail and road, is as follows:—

	Rail.		Road.		
Upon a level, as	10	is to	80	=	8 times.
Up 1 in 100, as	32	„	102	=	3 „
Up 1 in 25, as	100	„	170	=	$1\frac{3}{4}$ „

Consequently assuming we require 1 horse power to pull an omnibus with 60 passengers weighing 6 tons on a level railway, we should require 10 horse power to draw this load *at the same velocity* up an incline of 1 in 25. To pull this 6 tons on a level road at the same velocity, we should require 8 horse power, but up an incline of 1 in 25, we should only require double or 16 horse power.

In Boston and Philadelphia the steepest gradient is 1 in 20.

Upon the proposed horse railways in France between Clermont and Riom, there are many gradients of 1 in 30, and some short ones 1 in 25. Upon the street railways in the United States there are inclines of 1 in 40, up which 2 horses draw an omnibus with 50 passengers. In cases where the inclination of the public roads is too steep, the plan proposed to be adopted in France for branch horse lines, is to divert the tramway from the road, and avoid the ascent by running round the slope of the hill. It would be always advisable to adopt this expedient for branch horse lines, in cases where it can be practically and economically carried out.

The Permanent Way.—Tramways may be divided into two classes, viz., those adapted for ordinary vehicles, and those adapted for a flanged wheel.

The primitive and most simple form of tramway consists in laying down two rows of flat stones perfectly level, and at such a distance apart, that the wheels of the vehicle revolve on the centre of the stones. Instances of this kind of tramway are to be seen on the Commercial Road, London; and on a small scale on many of the narrow streets. Cast-iron plates instead of stones have lately been proposed for tramways in London. This kind of tramway may be used by all classes of vehicles, may be crossed transversely, and does not offer any obstruction to the ordinary traffic.

The next simplest form of tramway adapted for ordinary vehicles has a guide or flange added to it, so as to keep the vehicles within the tram: see fig. 1.

This system has been adopted in France upon a tramway from Strasburg to Mutzig. Various other forms, the same in principle, but with slight modifications in detail, have been adopted in England and other countries.

The next class are the tramroads for flanged vehicles and for a special species of carriage. The simplest form of this kind of tramway exists in the mineral districts in England, and consists simply in spiking down square or round bars of iron to longitudinal sleepers.

Most of the forms hitherto adopted for flanged wheels have been designed simply to accommodate the requirements of the tramway itself without reference to other interests.

As we propose to lay the rails along the public roads and streets, a form of rail must be adopted, which not only meets the requirements of the tramroad itself, but must not cause an impediment to the ordinary road traffic. Various forms of rails have been proposed by various persons to accomplish this object: see figs. 2, 3, 4, 5.

The form of rail used upon the tramway from Paris to Versailles is the invention of M. Loubat, and is called the "System Loubat." This kind of rail is proposed to be used by the Anglo-French Company for their first line of horse railway in France, from Clermont to Riom. The sketches, figs. 6 and 7, show the section of the Loubat rail, and the mode of construction. The rail is of wrought iron, and weighs 35 lbs. per yard. It has been found by experience to answer well.

The sketch, fig. 8, shows the section of the rail used on the Second Avenue tramway, New York. It is of wrought iron, and weighs 64 lbs. per yard.

The sketch, fig. 9, shows the latest form of section adopted in New York. This rail can be used as a tramway for the ordinary vehicles as well as for vehicles with flanged wheels. This rail has been laid down at Birkenhead, the raised flange being laid on the outside.

Mr. Samuel, C.E., of London, and Mr. Train, have patented an improvement on this rail: see Plate III., fig. 10. The object of the two flanges being that the rail can be turned over when one surface has been worn away.

The sketch, fig. 11, shows the section of the rail used in Dorchester Avenue tramway, and the Metropolitan tramway, Boston, United States. It is of cast iron, and weighs 75 lbs. per yard. This form of rail is the invention of Mr. C. L. Light, C.E.

The chief object in designing forms of rail for street railways is to make the rail answer all the purposes of the tramway and, at the same time, not offer any obstruction to the ordinary traffic, also that the groove into which the flange runs shall not get clogged up, but shall work itself clear. This object, we think, is best attained by Mr. Light's rail, fig. 11. The groove is not so deep as the New York rail, fig. 8, still it is found to be quite deep enough to guide the wheels, and offers less obstruction to the ordinary traffic. It has been found in cases where the groove is too deep and too wide, that the narrow wheel-tires of other vehicles get into the groove, and are often torn off in consequence. The inside bevil of the rail allows small pebbles that get in the groove to be pushed out of the way up the bevil by the flange of the wheels without crushing them, thereby preventing them from being the cause of throwing the omnibus off the track. The rails are cast in lengths of 8 feet, and have a dowel and socket cast on the ends, so that the rails fit into each other at the joints, each length is fastened to the sleepers by three spikes: see fig. 12. Mr. Maquisten, in his Report to the City Council of Montreal, says that the cast iron rails at Boston, except on curves, have proved a failure.

The New York rail, fig. 9, is well adapted for streets, and under circumstances where it is intended that the ordinary traffic shall have the benefit of the tramway. This section of rail might, we think, be advantageously adopted in London, and if laid down by the City authorities, the ordinary traffic would have the benefit of it gratis, and a charge might be made for all omnibuses or other vehicles running upon the tramway with flanged wheels. This would prove a source of income, and would no doubt pay a large interest upon the outlay; besides which, it would concentrate the traffic into fewer vehicles and into a smaller space, and would prevent in a great measure that overcrowding of the streets which is now annually increasing, and for which we must very soon find a remedy.

In New York, people have the wheels of their carriages and other vehicles made to the gauge of the tramway, in order to be able to use it. This is done without causing any impediment to the tramway omnibuses.

One disadvantage of this tramrail is, that the broad smooth surface of the iron tram being in the path of the two horses drawing the railway omnibus, or other vehicles using the tram, does not afford any hold for their feet and causes them to slip. The same applies to the horses of all vehicles using the road on which such a tramrail is laid. To obviate this disadvantage, the author proposes to make grooves on the surface of the tram, as shown in Plate IV., figs. 13, 14, 15, 16. There may be two lines of grooves, longitudinal and transverse, as shown in fig. 15, or one transverse line of grooves, as shown in fig. 16.

Another disadvantage of this rail is the rise of the flange above the level of the roadway inside the rails. See fig. 13. This rise although slight, and seldom more than 1 inch, still is found to cause considerable inconvenience to vehicles crossing the rails in an oblique direction.

On the other hand, this form of rail has an advantage over the grooved rail, viz., that the flange of the wheel is always free, and there is no groove to fill up and obstruct it. In order to combine the two objects of this rail, viz., a railway for flanged-wheel vehicles, and a tramway for ordinary vehicles, and at the same time to avoid the disadvantages of the raised flange and the broad smooth tram, the author has devised a tramrail which will avoid the above-named disadvantages, and at the same time will accomplish the object sought to be attained. This tramrail is shown in Plate V,, figs. 17, 18, 19. The groove, A, see fig. 17, is for the flange of the wheel, and that part of the surface, B, is the bearing surface for the tyre of the flanged wheel. The remaining portion forms a tramway for ordinary vehicles. The width of this tramrail may vary according to local circumstances and requirements.

In the previous designs the rails are fixed upon wooden longitudinal and cross sleepers—the construction being similar to the construction of "way" of Locomotive Railways. We consider, however, that for street railways, especially where laid in paved streets, the foundation should be of more durable material than timber, for any disturbance of the rails to repair the foundation, impedes not only the traffic on the railway, but also the ordinary street traffic.

Timber sleepers buried only a few inches under the surface between wet and dry soon rot, unless thoroughly prepared with creosote. Timber is also, compared with iron, dear in England. We are therefore of opinion, that for streets—especially paved streets—timber should be avoided, and the foundation of the rail composed entirely of iron. The author has designed two plans to effect the above-named object, which are shown in Plates VI. and VII., and will be readily understood by reference to them In Plate VI. the rail is rolled in the form shown in the cross section, fig. 20, and is suspended upon cast iron sleepers: see fig. 22. The rail shown in Plate VII. is rolled or cast in the form shown in cross section, fig. 24, forming a simple girder, being held laterally in its position by cast iron cross sleepers.

In all the previous designs, with the exception of the New York tramrail and its modifications, shown in figs. 9, 10, and 13, a groove is formed in the rail for the flange of the wheel to run in. We do not, however, consider a groove in the rail to be absolutely necessary. The New York tramrail, fig. 9, has not any groove, but the flange of the wheel is guided by the raised flange of the rail. If we dispense with the broad iron tram of this rail, we can substitute paving or macadam in its stead, and the rail will then become as shown in Plate VIII., fig. 27, being simply a girder rail. In cases where a rail of the above section is laid in paved streets, the paving-stones within the rails can be pitched three-quarters of an inch lower than the paving on the outside, as shown in figs. 28 and 31, and where laid on macadamised roads, the flange of the wheel will always work a groove for itself, as shown in fig. 27. The fact of the groove being made of iron does not prevent its becoming filled with dust, dirt, and pebbles, and we cannot see any reason why the groove in the iron rail on the broad iron tram is easier to keep free, than the tram formed by the paving-stones, or the indentation caused by the flange in the macadam. The cost of construction, according to this system, as shown in Estimate No. 7. page 68, is much cheaper than any other system, but if it be laid down in macadamised roads, and a granite tram be laid down, as shown in fig. 31, this will increase the cost by £500 per mile.

The sketch, fig. 28, shows the section of the rail at the joints, the object being to make the cast iron cross girder support the rail, keep it laterally in its position, and also answer the purpose of a fish plate. A wrought iron fish plate is shown on the outer side of the rail—this being bolted to the flange of the cross girder would effectually "fish" the joint.

Ballast and Paving.—The sleepers, whether of iron or wood, must be laid on a firm foundation of gravel or broken stone. This would generally be formed under all roads at a depth from 6 to 12 inches.

The cost for ballast and paving will in most cases be chiefly for labour. In cases where the rails are laid along paved streets the stones are merely taken up and re-laid, and there is generally a surplus of stone by so much as the space occupied by the rails and sleepers. Where the rails are laid along macadamised roads, the macadam must be removed, screened, and re-laid, and a fresh quantity supplied if necessary.

It is found, that if the space between rails be laid with macadam, that the groove of the rail becomes often filled up with pebbles or small stones which are cast about by the horses' hoofs; when this space is paved with stone this advantage does not exist.

The macadamised road has on the other hand the advantage of being easier for the horses to travel upon, gives them a better footing, and does not injure their hoofs and legs so much as the continual running on the paved stones.

Passing Places and Sidings.—In cases where only a single line of rail is used, it is necessary to make some provision for the return traffic in the opposite direction. On the French branch lines they propose to make passing stations of 1000 metres (3300 feet long) in length, at distances of 4000 metres (2½ miles) apart.

The single line of rails is laid in the middle of the road. In cases where a double line is used, the centre of the road is midway between the two lines. In New York, through streets too narrow to admit of a double line, the practice is to lay a single line down one street, and another line for the return traffic down a parallel street. To avoid the necessity of having a second line of rails for the return traffic, one or other of the inventions for the moveable or shifting flange described in page 61, could be adopted so as to enable the street railway omnibuses to pass each other.

Stations.—For street Railways—stations are unnecessary. For country branch lines it will be necessary to afford some accommodation for the passengers at the intermediate stations and at the termini. It will also be necessary to construct sheds to store perishable goods ; in fact the general arrangements and cost of the stations will be similar to small stations on branch Locomotive lines. We avoid the cost of Locomotive sheds, coke sheds, and water apparatus, but on the other hand we must have stabling for the horses and storehouses for the provender.

Rolling Stock.—As the speed on horse railways is never likely to exceed 10 miles per hour, and as we propose to reduce the gauge to 3 feet 6 inches for branch lines, the rolling stock for branch lines can be made much lighter than for Locomotive railways, and can be much more cheaply constructed. It will not be necessary to have springs or expensive axle boxes for the wheels of the goods trucks, nor many other expensive appliances which are necessary upon the Locomotive railway. The passenger omnibuses may be constructed like ordinary omnibuses, and may be made, if necessary, sufficiently large to accommodate 70 to 100 passengers. The wheels of the omnibuses and other rolling stock need not have a greater diameter than 2 feet 6 inches. The leading wheels of the passenger omnibuses can be made to turn if necessary, so that they may be used on the common roads, but when on the tramway they must be fixed, otherwise any swerving by the horses out of the direct line would draw the omnibus off the rails. On the Paris and Versailles tramroad, the framework and axles of the leading wheels is fixed and kept in position by an iron pin, which can be removed at pleasure. On this line only two out of the four wheels have flanges, the flanged wheels are often removed when the omnibuses arrive at the terminus in Paris, and are replaced by ordinary wheels; the omnibus can then be drawn through the streets of the city like the ordinary omnibuses. To each omnibus is attached a powerful break.

In many of the American lines the axles of the omnibuses are fixed like ordinary railway carriages, so that the omnibus can travel in both directions without turning. Upon the arrival of the omnibus at the end of its journey, the horses are loosened and then hooked to the other end of the omnibus.

In order to enable omnibuses to pass each other when travelling in opposite directions on the same line of rails, or to pass other vehicles travelling in the same direction, several ingenious contrivances have been invented for a moveable or shifting flange, so as to enable the street railway omnibuses to travel on the road and on the rails with equal facility. Mr. W. J. Curtis, C.E., was we believe the originator of the idea, and to him is consequently due the chief merit of the invention; but others, amongst whom is the author, have invented contrivances to accomplish the same object by different means. Mr. Curtis' invention may be briefly described as follows:—The wheels of the street railway omnibuses are made rather broader than usual, and revolve loose upon the axle. A portion of the axle for about three inches in length, on the inner side of each wheel is formed excentric for a depth of about one inch, or whatever depth may be required for the flange when in contact with the rail. Upon this excentric portion of the axle there is another wheel or disc abutting close against the bearing wheel, thus constituting a flange. This also revolves loose upon the excentric portion of the axle. When it is intended that the omnibus should run on the rails, the axle is turned half a revolution by a lever in communication with the driver; and the excentric portion of the axle is depressed, and the disc is lowered. This enters into the groove of the rail, and performs the same object as a fixed flange. When it is required that the omnibus shall run off the rails, the driver of the omnibus by a similar action with the lever turns the axle half a turn, and raises the excentric, and this raises the disc out of the groove of the rail, and the omnibus can then be drawn off the rails.

Mr. R. Main, coachbuilder of Birkenhead, has invented a self-acting moveable flange. For this purpose, a hollow space is formed in the felloe of the wheel, in which is inserted a series of segmental links, connected together by pins, and forming together a band or chain all round the wheel ; or, instead of this chain, he substitutes a continuous ring. The inside of the ring rests against springs fixed on the inner part of the felloe, and the outer part of the ring or chain is then made to project beyond the tyre, and form a projecting ring or flange in the circumference of the wheel, so as to be capable of holding and guiding the wheel on the tram or rail. By this construction of the wheel, the weight of the carriage to which it is applied when running on the road, will press the flange inwardly against the springs so as to admit of the wheels of the carriage running with the required smoothness on ordinary ground. Wheels thus constructed, will be self-acting by the mere effect of the ground or surface on which the wheels rest, either being made to press the elastic spring or flange inwards to a level with the tyre, or allowing the same to be projected by the springs beyond the edge of the tram or rail on which the tyre rests.

Mr. James Samuel, C.E., proposes a contrivance which will answer the same purpose as a moveable flange, in cases where the rail laid down is not a grooved rail, but similar to the New York tram rail. (Plate III., fig. 9.) For this purpose he makes a fixed projecting flange to the wheel, the flange being of such a strength and width, that when the street railway omnibus is off the rails, it can run on the flange, and when on the rail it runs on the periphery of the wheel. The same object may also be accomplished by other contrivances.

Cost of Construction.—The cost of construction will of course vary according to the value of material and labour in the locality. The cost of rolling work and for horses will depend upon the amount of traffic and the quantity required.

The estimate of the French engineer for the proposed lines from Clermont to Riom, in the department of Puy de Dôme, a distance of 16 kilometers, is as follows: the quantities and prices reduced to the English standard.

The section of rail is a lighter section of the "Loubat" rail (fig. 6), weighing 20 lbs. to the yard. The total length of single line, including passing stations, is 19 kilometers, or $11\frac{9}{10}$ miles.

Estimate.

			AT	£	s.	£	s.
Rails . . .	Tons.	375	14/0/0	5250	0		
Spikes, 10″ long with nuts and plates	Tons.	38	40/0/0	1520	0		
Points and crossings .	,,	21	3/5/0	68	5		
Carried forward						£6838	5

		AT	£	s.	£	s.
Brought forward . .			6838	5		
Wooden turntable, shod with iron . . . Tons.	7	40/0/0	280	0		
Oak timber for sleepers 6″×4″ . . . . C. ft.	39,025	1/10½	3658	11		
Oak wedges	30,124	/1½	188	5		
Metalling . . C. yds.	14,000	5/6	3850	0		
Sand under sleepers . „	1,056	2/0	105	6		
New paving . . Sq. yds.	376	5/9	108	1		
Relaying old paving „	3,510	8/¼	126	17		
Stone curb to pavement L. yds.	9,844	2/9	1353	11		
Diverting footpath — excavation . . . C. yds.	3,600	/7½	112	10		
Gutters to drains under footpath	356	1/0/0	356	0		
Five open passenger waiting sheds at five stations Sq. yds.	117	1/7/0	157	19		
Control house at Chateaugay Sq. yds.	72	5/0/0	360	0		
Laying rails and sleepers yds.	20,994	1/6	1574	11		
			£19,069	16		
Profit to Contractor—10 per cent.			1,906	19		
Contingencies			1,023	5		
					22,000	0

Workshops and Rolling Stock.

		£	£	s.
Stations at Clermont and Riom, including carriage sheds, stabling and workshops . . . each at	£400	£800		
15 Omnibuses for 25 passengers „	160	2,400		
10 Goods' trucks . . . „	60	600		
50 Horses with harness . . „	40	2,000		
			5,800	0

Preliminary Expenses, Administration.

	£	s.
Plans, surveys, and indemnity to the Concessionees	5,700	0
Total cost	£38,500	0

The total length of single line being 11 $\frac{9}{10}$ miles, the cost per mile is as follows :

Construction of the line	£1850 per mile.
Omnibuses and rolling stock	480 „
Preliminary and miscellaneous expenses	470 „
Total cost per mile	£2800

The estimate of M. Davène, the French Government engineer, for the line from Arras to Etaples, in the Pas de Calais, with branches to Bethune and Frevent, a total length of 165 kilometers, or 103 miles, is as follows.

The rail used is the same as for the Clermont Riom line, weighing 20 lbs. to the yard, with oak sleepers, as shown in fig. 6.

Cost of Construction per Mile.

	£	£
The Permanent way	1609	
Land and Compensation	220	
Earthwork	100	
Bridges, culverts, and works of art	55	
Cost of line		1984

Stations.

Seven intermediate stations	at £2400	£16,800	
One central station		9600	
		£26,400	
$\frac{26,400}{103}$ = per mile			256

Rolling Stock and Horses.

13	Omnibuses for passengers	at £160	£2080	
368	Goods trucks	80	29,440	
282	Horses	32	9024	
			£40,544	
	$\frac{40,544}{103}$ = per mile			393
	Total cost per mile			£2633

We will now estimate the comparative cost per mile of Horse Railways in England constructed according to seven different systems, as shown in the accompanying designs, viz., the "Loubat" rail, fig. 6, the improved New York tram-rail, fig. 10, Mr. Light's rail, fig. 11, the tram-rail, fig. 17, and the three designs shown in Plates VI, VII, and VIII. We will assume that, with the exception of the last three designs, that they are all laid upon longitudinal sleepers of creosoted Baltic timber, with transverse sleepers 4 feet 6 inches apart. In order to make a just comparison, we will assume that the width of gauge is 4 feet 8½ inches, and that the rails are laid down on a macadamised road, and that it is necessary to excavate the trench to the full width of 6 feet. We will also assume that no fresh material (broken stone or paving) is required for reinstating the road, and that no expensive works of art, such as bridges, culverts, &c., are required.

Estimate No. 1.

"Loubat Rail," fig. 9, weight 35 lbs. per yard.

							£	s.	d.
Rails	tons	55	@	7	10	0	412	0	0
Plates	lbs.	267	@	0	0	2	2	4	6
Spikes	lbs.	1320	@	0	0	3	16	10	0
Timber sleepers, creosoted	c. ft.	4550	@	0	3	0	682	10	0
Laying rails, including Excavation, filling in, punning, screening old materials, and carting away surplus material	L yds.	1760	@	0	4	0	352	0	0
Contingencies							150	0	0
				Total cost of construction			£1615	4	6

Estimate No. 2.

The Improved New York Tramrail, fig. 10, weight 60 lbs. per yard.

							£	s.	d.
Rails	tons	95	@	7	10	0	712	10	0
Plates, spikes, and nails .	„	2	@	15	0	0	30	0	0
Cast iron brackets . . .	„	2	@	6	0	0	12	0	0
Timber sleepers, creosoted .	c. ft.	4550	@	0	3	0	682	10	0
Laying rails, excavation, &c.	L yds.	1760	@	0	4	0	352	0	0
Contingencies							150	0	0
Total cost of construction							£1939	0	0

Estimate No. 3.

Mr. Light's Rail, fig. 11, weight 75 lbs. per yard.

							£	s.	d.
Cast iron rails . . .	tons	118	@	5	10	0	649	0	0
Plates, spikes, nails, &c. .							30	0	0
Timber sleepers, creosoted .	c. ft.	4450	@	0	3	0	682	10	0
Laying rails, excavation, &c.	L yds.	1760	@	0	4	0	352	0	0
Contingencies							150	0	0
Total cost of construction							£1863	10	0

Estimate No. 4.

The Cast Iron Tramrail, fig. 17, 7½ in. wide, weight 60 lbs. per yard.

							£	s.	d.
Cast iron rails . . .	tons	95	@	5	10	0	522	10	0
Plates, spikes, nails, &c.							30	0	0
Timber sleepers, creosoted .	c. ft.	4550	@	0	3	0	682	10	0
Laying road, excavation, &c.	L yds.	1760	@	0	4	0	352	0	0
Contingencies							150	0	0
Total cost of construction							£1737	0	0

Estimate No. 5.

Wrought Iron T Rail, fig. 20, weight 50 lbs. per yard.

							£	s.	d.
Rails	tons	79	@	7	10	0	592	10	0
Cast iron chairs and sleepers	„	60	@	5	10	0	330	0	0
Wrought iron in fish plates, bolts, &c.	„	1¼	@	15	0	0	18	15	0
Laying rails, excavation, &c.	L yds.	1760	@	0	3	6	308	0	0
Contingencies							150	0	0
Total cost of construction							£1399	5	0

Estimate No. 6.

Cast Iron Grooved Girder Rail, fig. 24, weight 100 lbs. per yard.

							£	s.	d.
Cast iron rails . . .	tons	158	@	5	10	0	869	0	0
Cast iron sleepers . . .	„	22	@	5	10	0	121	0	0
Wrought iron bolts . .	„	4	@	30	0	0	120	0	0
Laying road, excavation, &c.	yds.	1760	@	0	3	6	308	0	0
Contingencies							150	0	0
		Total cost of construction					£1568	0	0

Estimate No. 7.

Cast Iron Girder Rail, fig. 27, weighs 80 lbs. per yard.

Cast iron rails . . .	tons	125	@	5	10	0	687	10	0
Cast iron cross sleepers .	„	12	@	5	10	0	66	0	0
Wrought iron in bolts, fish plates, rivets, &c. . . .	„	5	@	15	0	0	75	0	0
Laying road, excavation, &c.	L yds.	1760	@	0	4	0	352	0	0
Contingencies							150	0	0
		Total cost of construction					£1330	10	0

According to these estimates,

	£	s.	d.
The improved New York Tramrail, fig. 10, costs per mile	1939	0	0
Mr Lights Rail, fig. 11, costs per mile	1863	0	0
Cast Iron Tramrail, 7½ in. wide, fig. 17, costs per mile	1737	0	0
The "Loubat" Rail, fig. 6, costs per mile . . .	1615	0	0
Cast Iron Grooved Girder Rail, fig. 24, costs per mile .	1568	0	0
Wrought Iron T Rail, fig. 20, costs per mile . . .	1400	0	0
Cast Iron Girder Rail, fig. 27, costs per mile * . .	1330	0	0

Taking the average of the above estimates, not including the estimates No. 2 and 4, which are intended to form a tramway for ordinary vehicles as well as a railway for flanged wheel vehicles, we may safely assume that the cost of a horse railway in England laid along a macadamised road, will not cost more than £2500 per mile, which is made up as follows :

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* If this Rail be laid down on a macadamised road, and a granite Tram be laid, as shown in Fig. 31, the cost will be increased £500 per mile.

Cost of construction	1500	0	0
Stations	250	0	0
Horses and rolling stock	500	0	0
Right of way compensation, engineering contingencies	250	0	0
Total cost	£2500	0	0

Should it be necessary to provide new material, such as new paving stones or new macadam, to reinstate the road, the cost of construction per mile will be considerably increased.

Revenue and Interest on Capital.—We can only repeat here what has been stated on this head in page 19. Assuming the gross receipts upon horse railways for branch lines to be the same as the average gross receipts upon existing branch Locomotive lines, viz. £600 per mile, and assuming the working expenses to be the same, or 60 per cent., this will give a net revenue of £240 per mile, which represents on the capital of £2500 per mile, nearly 10 per cent.

M. Davène, the French Government engineer, estimates the cost of the line from Arras to Etaples in the Pas de Calais 103½ miles long at £272,000. The total annual receipts are estimated at £52,000. The total annual expenditure, not including sinking fund and depreciation of stock, is estimated at £25,000. The net annual receipts being £27,000, equalling 10 per cent. interest upon the capital. The Government impose upon any company who shall construct and work the tramway, the rather onerous condition of keeping the entire road in repair. Of the item £25,000 for annual expenditure £8000 is for this purpose.

The maximum tariff of charges are for

First class passengers	per mile	2½*d.*
Second class passengers	„	2*d.*
Outside passengers	„	1½*d.*
Goods—average per ton	„	3½d.

For carrying out horse railways in England along the existing public roads, we conceive it will be necessary to obtain a general Act—on the same principle as the Act for Scotland, and that any company should have the right to construct them under its power.

The maximum tolls proposed to be charged under Sir R. Ferguson's Act for Ireland, are

For every passenger conveyed in a first class carriage	2*d.*	per mile
For every passenger conveyed in a carriage of an inferior class	1½d.	„
For the carriage of minerals and undressed materials		„
For use of tramway . . . . per ton	1*d.*	„
If conveyed in Company's trucks . . .	1⅛*d.*	„
If drawn by Company's horses	1½*d.*	„
For all goods, wares, merchandise, for use of tramway	2*d.*	„
If conveyed on Company's trucks . . .	2½*d.*	„
If drawn by Company's horses . . .	3*d.*	„
For small parcels—not exceeding . . 7 lbs.	6*d.*	
„ „ . . 14 lbs.	9*d.*	
„ „ . . 28 lbs.	1*s.*0*d.*	
„ „ . . 56 lbs.	1*s.*6*d.*	

As regards the probable revenue of street railways in England, we can form an approximate estimate when we consider that the street railway companies in the United States have for reasons, as stated in page 23, a much larger capital than is necessary—certainly four times larger than would be necessary in England—yet still pay dividends to the shareholders from 10 to 12 per cent. We may, therefore, reasonably conclude that street railways in the large cities of the United Kingdom would pay at least the highest interest paid in the United States, or 14 per cent.

Mr. Thomas Wright, C.E., who proposed ten years ago to carry out a system of Street Railways in London, estimates the probable returns at 25 per cent. interest on the capital. He published a Prospectus at the time, which contains interesting statistics, an extract of which we subjoin. He says:—

"From official documents respecting the Stage Coach Duty and the Railways, it is stated that 3000 omnibuses in London and the suburbs carry not less than 300,000,000 of passengers yearly, an amount equal to one third of the population of the world, employing 11,000 men, and working a capital of 1,000,000*l.*, with an annual expenditure of 1,700,000*l.*, and paying to government a duty of 400,000*l.*, or as much as all the stage coaches in the empire contributed before the establishment of railways, and the whole of this most invaluable traffic is available for the successful operations of this Company.

"Assuming, that in laying down a complete system of Street Railways for the accommodation of this metropolis and its suburbs, would require 100 miles of double railway, hence 3000*l.* per mile, which would cover every expense connected therewith, except furnishing, that would only amount to 300,000*l.*, and would give almost universal accommodation, and that without injury to any existing street interests.

"Assuming also, instead of 3000 omnibuses, that only 1800 of the proposed railway carriages, &c., would be required for furnishing the railway at 200*l.* each, equal 360,000*l.*, and also 1800 horses would be required at 40*l.* each, inclusive of harness, &c., equal 72,000*l.*, together amounting to 432,000*l.* for furnishing, &c.; this then, with the cost of railway permanent way 300,000*l.*, makes the total amount 732,000*l.*, adding to this the cost of relays,. stations, parliamentary expenses, contingencies, &c.; hence we propose a capital of one million. It is therefore evident that the number of horses at present employed would be reduced more than one half, and with that the entire space they occupy in the streets, besides dispensing with a large number of miscellaneous omnibuses started at the caprice of their proprietors, but which unnecessarily throng the streets of the metropolis, consequently, by these and other means, a large amount of space will be gained and made available for the progress of other vehicles.

"It has been asserted that the average profits of existing omnibuses may be taken at 185*l.* per annum, and the outlay of capital for one omnibus, including 10 horses with harness complete 330*l.* The current expenses also of one omnibus for one year, including duty on miles travelled 816*l.* And the earnings of one omnibus for one year at 419*l.* 5s. per week is 1001*l.*, hence the current annual expenses deducted from the earnings 1001*l.* gives the annual profit of 185*l.* This then, on 3000 omnibuses is 555,000*l.*, being a clear return of 185*l.* per annum for each outlay of 330*l.*, or at the rate of 50 per cent. per annum.

"But again, assuming that the present 3000 omnibuses are earning only 2*l.* per day each, that equals 6000*l.*, and that during 365 days or one year, equals 2,190,000*l.* Hence as a train of three of the proposed railway carriages are equivalent to five ordinary omnibuses earning 2*l.* per day each, and allowing 75 per cent. per annum for working expenses, leaves 547,500*l.* for dividend; this, therefore on a capital of 1,000,000*l.* gives the shareholders in the Metropolitan Streets Railway Company a most remunerative dividend, leaving altogether unnoticed the profits arising from parcels delivery and goods; therefore with the inherent reduced expenses, and increased capacity for additional work of a railway, the profits would be materially increased.

"But taking a still more reasonable estimate, that of a minimum fare at 1d. each on 300,000,000 passengers, amounts to 1,250,000*l.* per annum, then deducting 75 per cent. for wear, tear, depreciation, general working and traffic expenses, maintenance of way, &c., leaves a clear income of 312,000*l.* for dividend, and on the capital 1,000,000*l.* gives 25 per cent. per annum for the shareholders, which may be expected fully to be realised."

For the guidance of municipal authorities in granting tramroad companies power to use the public streets and thoroughfares under their control, we have appended hereto the charter of the Dorchester Avenue Railway Company in Boston, United States.

Conclusion.—Having now endeavoured to show the principles and economy of horse railways, and described the various modes of construction that have been adopted in different countries; having, also, endeavoured to show the advantages of adopting this cheap and simple system for Street Railways, and adopting it in the place of expensive Locomotive railways for branch lines,—we will conclude by hoping that the publication of this short pamphlet will have some effect in calling public attention to the advantages of horse railways and that it will tend to the formation of companies for carrying them out.

We have endeavoured to show that it is not absolutely necessary to use a Locomotive engine as the tractive power, simply because the passengers are conveyed in carriages which run in flanged wheels upon iron rails; but that horse power is in many instances more convenient and economical, and will answer all requirements. We hope the remembrance of this simple fact, which appears to have been forgotten during the last twenty years of the locomotive railway mania, will induce existing Railway Companies to discontinue the construction of expensive Locomotive railways for branch lines, and that they will promote the construction of this cheap and simple system.

2, DELAHAY STREET, LONDON,
March, 1860.

APPENDIX.

CHARTER.

COMMONWEALTH OF MASSACHUSETTS.

In the year One Thousand eight hundred and fifty-four.

AN ACT TO INCORPORATE THE DORCHESTER AVENUE RAILROAD COMPANY.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same as follows:

SECTION 1. Cheever Newhall, Edward King, John J. May, their associates and successors, are hereby made a Corporation by the name of "THE DORCHESTER AVENUE RAILROAD COMPANY," with power to construct, maintain, and use a railway or railways, with convenient single or double tracks, from a point near the Lower Mills so called, in the town of Dorchester, upon and over the way or street heretofore known by the name of the Dorchester Turnpike, or Turnpike Street, to the line of the City of Boston, and thence upon and over such street in South Boston, as the Mayor and Aldermen of the City of Boston may determine, upon and over the North Free Bridge, and upon and over Sea and Broad Streets in the direction of State Street in said Boston, as shall from time to time be fixed and determined by vote of the Mayor and Aldermen of said city, and assented to in writing by said Railroad Corporation: provided that all tracks of said Railroad shall be laid at such distance from the sidewalks in the City of Boston and town of Dorchester, as the Mayor and Aldermen of said city and the Selectmen of said town respectively, shall determine to be for the public safety and convenience, and the written assent of said Corporation to any vote of the Mayor and Aldermen of said city, or of the Selectmen of the said town, respectively, prescribing from time to time the route of said railroad, shall be filed with the respective Clerks of said city and town, and shall be taken and

Plate 4

Fig. 13.

Cross Section at A.B.

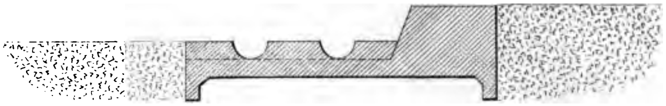


Fig. 14

Longitudinal Section at C.D.

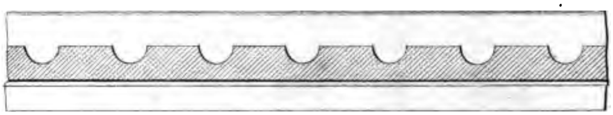
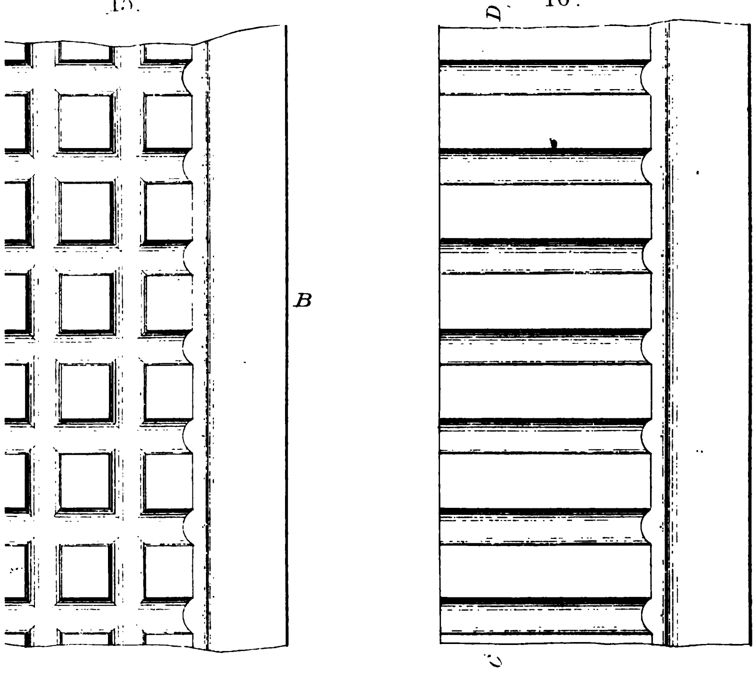


Fig.s

Plan



15.

16.

Scale 3 inches to the foot

[illegible]

deemed locations thereof; * and provided, that before the location or construction of any track in any street or highway, the Mayor and Aldermen of said city and the Selectmen of said town, respectively, shall give notice to the abuttors thereon, by the publication in one or more newspapers published in the said City of Boston and in the County of Norfolk, of an order of notice from said Mayor and Aldermen and Selectmen, respectively, fourteen days at least, prior to the hearing upon the location of any part of such track, that the said abuttors may show cause, if any there be, why said track should not be so located and constructed; and the said Railroad Corporation shall have power to fix, from time to time, such rates of compensation for transporting persons or property thereon, as they may deem expedient, provided that the rates of fare between any two stations in the City of Boston shall never exceed five cents for each passage of a person, unless with the assent of the Mayor and Aldermen of said city; and the said Railroad Corporation shall be subject to all the duties, restrictions and liabilities, and entitled to all the rights and privileges, prescribed by the forty-fourth chapter of the Revised Statutes.

SECT. 2. The said tracks or railroad shall be operated and used by said Corporation with horse power only, and it shall not connect its track with any other railroad on which other power is used. The Mayor and Aldermen of said city, and the Selectmen of said town, respectively, shall have power at all times, to make all such regulations as to the rate of speed, and mode of use of said tracks, as the public convenience and safety may require.

SECT. 3. Said Corporation shall maintain and keep in repair such portions of the streets and bridges in the City of Boston, as shall be occupied by their tracks; and they shall also keep the whole of the bed of any road in the town of Dorchester, which shall be thus occupied, in such repair, that the public travel or teaming over said Dorchester turnpike, within the limits of the town of Dorchester, shall be well accommodated while said Railroad Corporation may continue to occupy any part of said turnpike under this act. † And the said Railroad Corporation shall be liable for any loss or injuries that any person may sustain by reason of any carelessness, neglect, or misconduct of its agents or servants, in the management, construction or use of said tracks or railroad, and in case any recovery

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* The location in Boston was made December 30, 1854, and assented to by the Company, January 10, 1855; in Dorchester, location made February 7, 1855, assented to May 15, 1855; and an additional location May 17, assented to May 19, 1855.

† See the Act in addition, &c., passed April 18, 1855.

shall be had against the said city or town, by reason of such defect or want of repair in, or use of, their said tracks or roads, said Corporation shall be liable to pay to said city and town, respectively, any sums thus recovered against them, together with all costs and reasonable expenditures incurred by said city or town, or either of them, in the defence of any such suit or suits, in which such recovery shall be had; and said Corporation shall not encumber any portion of the streets not occupied by the said Railroad or tracks.

SECT. 4. If any person shall wilfully or maliciously obstruct said Corporation in the use of said road or tracks, or the passing of the cars or carriages of said Corporation thereon, such persons, and all who shall be aiding or abetting therein, shall be punished by a fine not exceeding five hundred dollars, or may be imprisoned in the common jail for a period not exceeding three months. If said Corporation, or its agents or servants, shall wilfully and maliciously obstruct any highway, or the passing of any carriages over the same, said Corporation shall be punished by a fine not exceeding five hundred dollars.

SECT. 5. The capital stock of the said Corporation shall not exceed the sum of three hundred thousand dollars, to be divided into shares of fifty dollars each.* And no shares shall be issued for a less sum to be actually paid in on each, than the par value of the shares which shall be first issued.

SECT. 6. Said Corporation shall have power to purchase and hold such real estate, within said city or town, as may be necessary or convenient for the purposes and management of said railroad.

SECT. 7. Either the said City of Boston or town of Dorchester, if it so elect, may, during the continuance of the charter of said Corporation, and after the expiration of ten years from the opening of any part of said railroad for use, purchase of said Corporation all the franchise, property, rights, and furniture of the said Corporation, by paying to said Corporation therefor, such a sum as will reimburse to each person, who may then be a stockholder therein, the par value of his stock, together with a net profit of ten per cent. per annum, from the time of the transfer of said stock to him on the books of the Corporation, deducting the dividends received by said stockholders thereon, said city and town having the right only to purchase that part of the corporate property within their own limits and jurisdiction respectively, and paying therefore a proportionate sum, on the basis above mentioned, to be ascertained and fixed by commissioners to be appointed by the Supreme Judicial Court.

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* The capital is fixed, by vote of the Corporation, at one hundred and fifty thousand dollars (150,000).

SECT. 8. At any time after the expiration of one year from the opening for use of the tracks of said railroad in any street or road in which the same may be located, as provided by its charter, the Mayor and Aldermen of the said city, and the Selectmen of the said town, respectively, may by vote of the major part thereof, determine as to so much of said track as is located within their respective limits, that the same or any part thereof be discontinued; and thereupon, the location shall be deemed to be revoked, and the tracks of said railroad shall forthwith be taken up and removed, in conformity with such vote or order of said Mayor and Aldermen, or Selectmen, provided that such taking up and removal shall be at the expense of said Railroad Corporation.

SECT. 9. The said railroad shall be constructed and maintained, in such form and manner, and upon such grade and with such gauge, as the said Mayor and Aldermen, and Selectmen respectively, may, in their votes fixing and determining the routes thereof prescribe and direct; and whenever, in the judgment of said Railroad Corporation, it shall be necessary to alter the grade of any street or road, so occupied by it, such alteration shall be made at the sole expense of said Corporation; provided, the same shall be assented to by the said Mayor and Aldermen, and Selectmen respectively.

SECT. 10. The said railroad, or any part thereof, shall not be constructed until the above mentioned street or way heretofore known as the Dorchester Turnpike, shall have been laid out as a public highway by the County Commissioners for the County of Norfolk, duly and according to law.*

SECT. 11. If at any time, for the greater convenience of that part of Boston called South Boston, it shall become desirable to construct a railroad by horse power from South Boston Point to the junction of Broadway and Turnpike Street, or other streets, any Corporation chartered for that purpose, shall have the right to connect with the road herein chartered, upon reasonable terms; such terms, in case of dispute, to be ascertained and determined by commissioners appointed for that purpose by the Supreme Judicial Court.

SECT. 12. Nothing in this Act shall be construed to prevent the authorities of said city or town, respectively, from taking up any of the public streets or roads traversed by said railroad, for the purposes for which they may now lawfully take up the same.

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* The Commissioners laid out said Turnpike as a public highway in 1854, and it is now known as Dorchester Avenue, through its whole length.

SECT. 13. This Act shall be void, so far as relates to the right to construct said road in either said city, or said town, unless the same shall be accepted by the City Council of the City of Boston, and the Selectmen of the town of Dorchester, and unless the same shall be accepted by the said Corporation, and ten per cent. of the capital stock thereof paid in within two years from the passage of this Act.*

SECT. 14. The said Company shall be deemed a Railroad Corporation, so far as to be subject to make such annual returns to the Legislature, as are or may be, prescribed by law, in relation to railroad corporations, but not to the other general provisions of law in relation to railroad corporations.

SECT. 15. The existence of said Corporation is hereby limited to the period of fifty years from the passage of this Act: *Provided, nevertheless*, that the Legislature may at any time, repeal this Act, or limit, restrict, or annul any powers herein granted.

HOUSE OF REPRESENTATIVES, *April*, 28, 1854.

Passed to be enacted,

OTIS P. LORD, *Speaker*.

IN SENATE, *April* 29, 1854.

Passed to be enacted,

CHARLES EDWARD COOK, *President*.

April 29, 1854. Approved,

EMORY WASHBURN.

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* All the requirements of this thirteenth section have been duly complied with.

COMMONWEALTH OF MASSACHUSETTS.

In the year One thousand eight hundred and fifty-five.

AN ACT IN ADDITION TO AN ACT TO INCORPORATE THE DORCHESTER AVENUE RAILROAD COMPANY.

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

SECTION 1. The Dorchester Avenue Railroad Company shall not be required to keep in repair any part of the bed of any road within the limits of the Town of Dorchester which shall not be actually occupied by the tracks of their railroad, anything in the third section of their Act of Incorporation, passed April 29, 1854, to the contrary notwithstanding.

SECT. 2. Said Corporation shall continue to be liable, as provided in said Act, for any defect or want of repair in such parts only of the roads in the town of Dorchester as shall be occupied by their tracks, but nothing contained in this Act shall release the said Corporation from any obligation now existing to repair or make good any damage to the whole bed of said road which shall be occasioned during the construction of their railroad: provided that the occupancy of said track shall be taken to be the space between the rails, and so much on each side thereof as shall be within the perpendicular let fall from the extreme width of any car or carriage used thereon, being the space from which the public travel is excluded during the passing of said car or carriage; and the structure and repairs of said portion of the road shall be such as not to interrupt the diagonal or parallel lines of travel of the public over said Avenue.

HOUSE OF REPRESENTATIVES, *April* 16, 1855.

Passed to be enacted,

DANIEL C. EDDY, *Speaker.*

IN SENATE, *April* 17, 1855.

Passed to be enacted,

HENRY W. BENCHLEY, *President.*

April 18, 1855. Approved,

HENRY J. GARDNER.

COMMONWEALTH OF MASSACHUSETTS.

In the year One thousand eight hundred and fifty-six.

AN ACT IN ADDITION TO AN ACT TO INCORPORATE THE DORCHESTER AVENUE RAILROAD COMPANY.

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:

SECTION 1. The Dorchester Avenue Railroad Company is hereby empowered to construct, maintain, and use a railway or railways, with convenient single or double tracks, to be operated by horse power only, upon and over such streets and ways within the limits of that part of the City of Boston, which was set off from the town of Dorchester by the four hundred and sixty-eighth chapter of the Acts of the year one thousand eight hundred and fifty-five, as the Mayor and Aldermen of said City of Boston may by their votes from time to time permit or determine; and also upon and over such streets and ways within the limits of the town of Dorchester, upon and over which the said Company has not heretofore been authorised to construct said railway, as the Selectmen of said town shall by their votes from time to time permit or determine.

SECT. 2. All tracks of said railroad shall be laid at such distances from the sidewalks in said City of Boston and town of Dorchester, and shall be constructed and maintained in such form and manner, and upon such grades, and with such gauge, as the Mayor and Aldermen of said city, and the Selectmen of said town, respectively, shall determine to be for the public safety and convenience; and before the location or construction of any track on any street or highway, the Mayor and Aldermen of said city, and Selectmen of said town, respectively, shall give notice to the abettors thereon, in the manner provided in the four hundred and thirty-fifth chapter of the Acts of the year one thousand eight hundred and fifty-four.

SECT. 3. The Mayor and Aldermen of said City of Boston, and the Selectmen of said town of Dorchester, shall, respectively, have and possess, in respect to the railway or railways constructed and maintained under this Act, and, the regulation of the rate of speed and mode of use of said tracks, and the discontinuance of the same, or any part thereof, all the powers conferred on them by the four hundred and thirty-fifth chapter of the Acts of the year one thousand eight hundred and fifty-four, and all the powers and rights and privileges by this Act conferred on said Dorchester Avenue Railroad Company, shall be subject to all the duties, liabilities, conditions, restrictions and provisions, contained in the four hundred and thirty-fifth chapter of the Acts of the year one thousand eight hundred and fifty-four, and in the two hundred and first chapter of the Acts of the year one thousand eight hundred and fifty-five.

HOUSE OF REPRESENTATIVES, *March* 21, 1856.

Passed to be enacted,

CHARLES A. PHELPS, *Speaker*.

IN SENATE, *March* 24, 1856.

Passed to be enacted,

ELIHU C. BAKER, *President*.

March 26, 1856. Approved,

HENRY J. GARDNER.

BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.

Plate N° 1

Fig. 1.

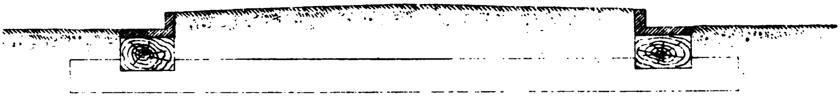


Fig 2.

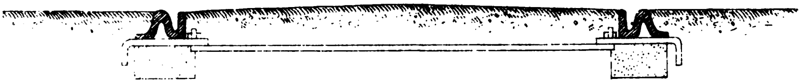


Fig. 3.

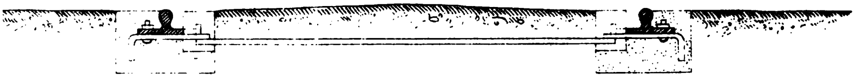


Fig 4.

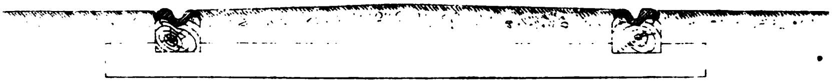
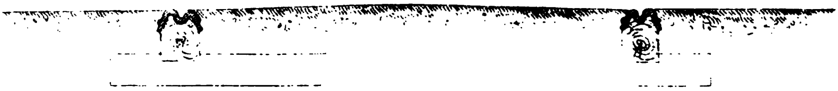


Fig. 5.



Kell Bros Lithrs Castle St Holborn.

Fig. 6

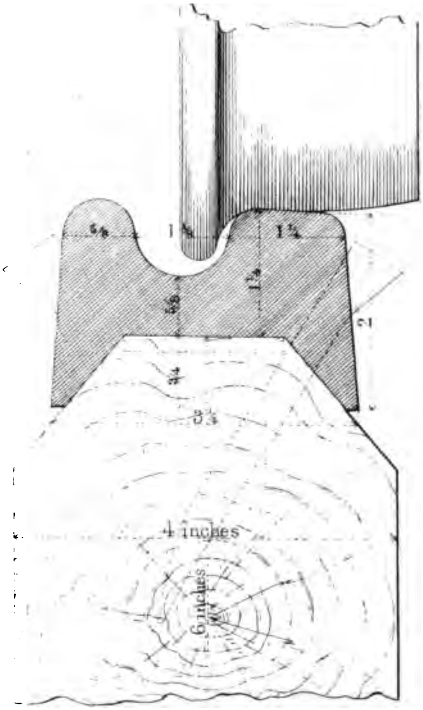


Fig. 7

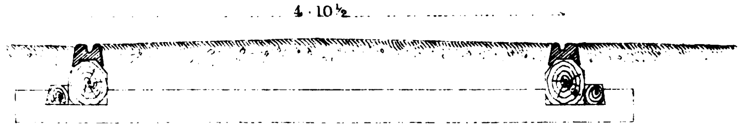


Fig. 8

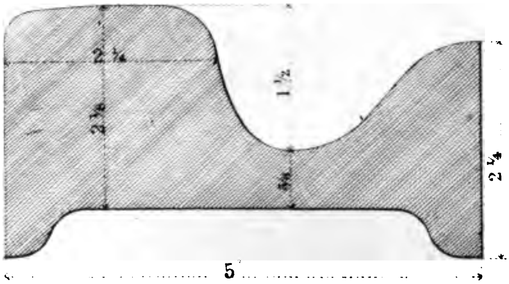


Plate IV.

Fig. 9.

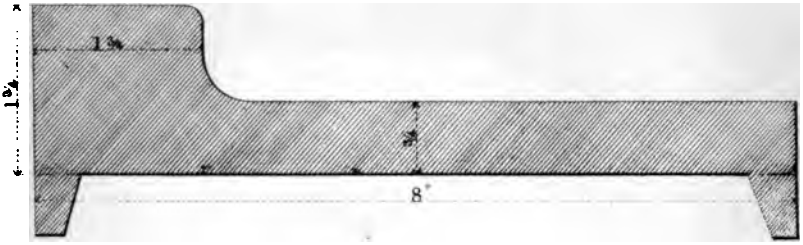


Fig. 10.
Section

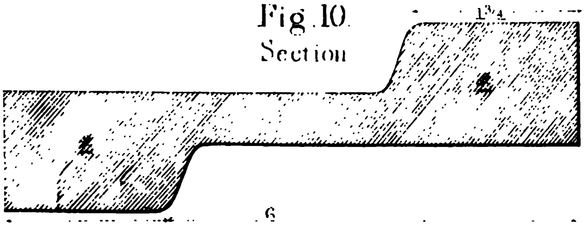


Fig. 11
Section

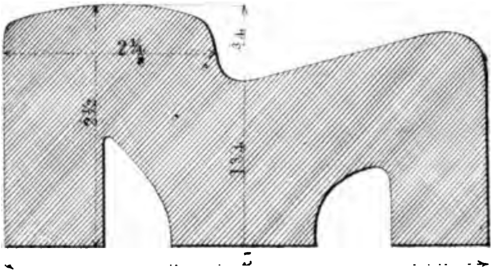
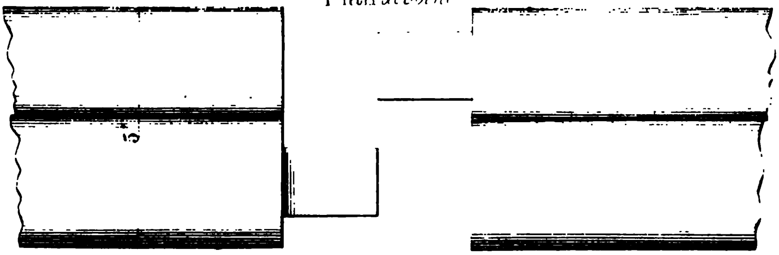


Fig. 12.
Plan at Joint



Kell, Bro^s. Lith^rs Castle S^t. Holb